

Cajón with Effects



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Design and Technology
MDP

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As a percussionist, I am interested in experimenting with different sounds produced by percussion instruments. The Cajón (pronounced ‘Ka-hon’) is a box-shaped Peruvian instrument that is played with the hands. The player sits on the drum and hits the front face, called the tapa, by slapping it with his/her fingers. Many Cajónes have snares, which allow the drum to produce both a heavy bass sound and a higher snare sound. I am particularly interested in the Cajón because of the many different sounds which it is capable of producing. I also have an affinity for electronics, and so had a desire to combine the electronic audio effects with the sound produced by the Cajón.

However, there are currently no Cajónes on the market which have both an inbuilt pickup and effects. Some players carry effects pedals with them to produce these effects, but it would be easier if they only had to carry the one box. I plan to build a Cajón with inbuilt effects and a direct output jack, so that it can be plugged straight into an amplifier or mixer. This way, the Cajón could be played with effects and amplification, or just acoustically without amplification.

CRITERIA TO EVALUATE SUCCESS

For my product to be successful it must:

FUNCTION

- Have an easy-to-use method to adjust the snares while playing the Cajón
- Produce a snare-drum-like sound when hit at the top, and a bass-drum sound when hit lower down
- Have inbuilt effects that can improve or modify the sound when manipulated
- Feel nice to play























AESTHETICS






- Be aesthetically pleasing – it must look good
- Be unique in design

OBSOLESCENCE

- Not physically degrade faster than a commercially manufactured Cajón

AREAS OF INVESTIGATION

What	How	Why
Cajón Design	 	<ul style="list-style-type: none">• To determine the most effective design to achieve the desired sound from the Cajón.
Types of Wood	 	<ul style="list-style-type: none">• To determine the most effective type of wood to build the Cajón in order to achieve the desired sound.
Snares and Strings	 	<ul style="list-style-type: none">• To determine the most effective method to achieve the desired snare sound from the Cajón.
Finishes	  	<ul style="list-style-type: none">• To determine the most effective finish that both looks good, and does not reduce the quality of sound from the Cajón.
Cushions/Pads	  	<ul style="list-style-type: none">• To determine whether a pad to place on the top of the Cajón is necessary, and determine the best material to use.
Microphones	  	<ul style="list-style-type: none">• To determine the most appropriate solution to the issue of adding a direct output from the Cajón.
Effects	  	<ul style="list-style-type: none">• To determine the most appropriate effects to add to the Cajón, as well as the best brand to use.
Skills		<ul style="list-style-type: none">• Computer-aided design skills will be required to design my product before production begins.• Woodworking skills will be required to build the Cajón.• Audio and electronic skills will be required to add an output jack and effects to the Cajón.
Safety		<ul style="list-style-type: none">• Safety will need to be taken into consideration when working with power tools to construct the Cajón.
Finance		<ul style="list-style-type: none">• To determine the amount of money required to build the product.
Time		<ul style="list-style-type: none">• To determine the amount of time that I have to design and develop a prototype of the product.

				
Internet Research	Observation Survey	Interviews	Finance Plan	Time Management Plan

FINANCE PLAN

Item	Purpose	Est. Price	Price
Wood	Back, sides, top and bottom	\$100	\$174.17
	Tapa	\$50	\$168.61
	Delivery Charge	\$0	\$26.82
Adjustable snare	Bolt	\$5	\$7.79
	Nut (for inside knob)	\$5	\$3.23
Screws	Attaching tapa	\$10	\$10.74
Snares	Snare sound (Different snares will be tested in prototype)	\$150	\$130
Pickup/Mic and Preamp	Direct output	\$200	\$200
Feet	To isolate the Cajón from the surface it is sitting on	\$20	\$18
	Screws for feet	\$5	\$3.48
Effects	Delay	\$100	\$65
	Reverb	\$100	
Miscellaneous Wires and Components	Adding direct output, effects and pedal	\$50	\$88.79
Finishes/Stains & Sandpaper for Finishing	Change the colour of the wood, Add uniqueness to the Cajón	\$50	\$24.20
TOTAL		\$845	\$920.83

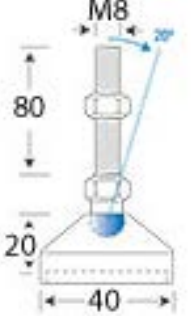
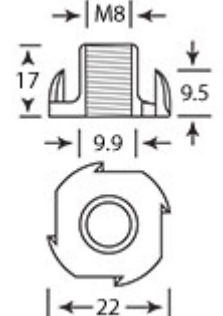
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Project Proposal and Project Management										
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Relationship to the Project Proposal										

CAJÓN DESIGN

FEET

I researched the feet for the Cajón. I found that although most Cajónes either use screw in or adhesive feet, very few have adjustable feet that allow the Cajón to sit in the preferred playing position – with the front slightly off the ground and the back on the ground. I decided to test the angle at which I sit when I play the Cajón to determine if it would be useful to have adjustable feet. I determined that adjustable feet would not work, as the thread length was not long enough to support the Cajón high enough off the ground. For this reason I have chosen not to use adjustable feet, and to instead use rubber feet. These will be tested in the prototype of the Cajón.

I conducted some research on buying adjustable feet. These are two products available from levelingfeet.com.au. On the left is the adjustable foot, on the right is the insert.

TLFS-5008	TDMi-4006
<p>Thread: M8 Thread Length: 80 Base Diameter: 40 Base Height: 20 Base Material: Nylon Maximum Static Load: 350 Thread Material: Stainless Steel</p>  <p>Price: \$7.95 each</p>	<p>Thread: M8 Height: 17mm Sleeve O/D: 9.9mm Flange: 22mm Height of Prongs: 9.5mm</p>  <p>Price: \$0.65 each</p>

I also conducted research on rubber feet. In my opinion, the most appropriate rubber feet to use are:

Speaker Cabinet Rubber Feet - Large	Rubber Feet Set of Four
<p>Diameter: 38mm Height: 20mm</p>  <p>Price: A\$10.90 + \$5.50 Shipping (Pack of 4)</p>	<p>Diameter: 36mm Height: 20mm</p>  <p>Price: A\$7.20 + \$11.38 Shipping (Pack of 4)</p>

Both sets of feet include a metal washer to ensure that the screw or bolt will not pull through the rubber.

I decided to use the second set of feet, as they looked more versatile, strong and less likely to break.

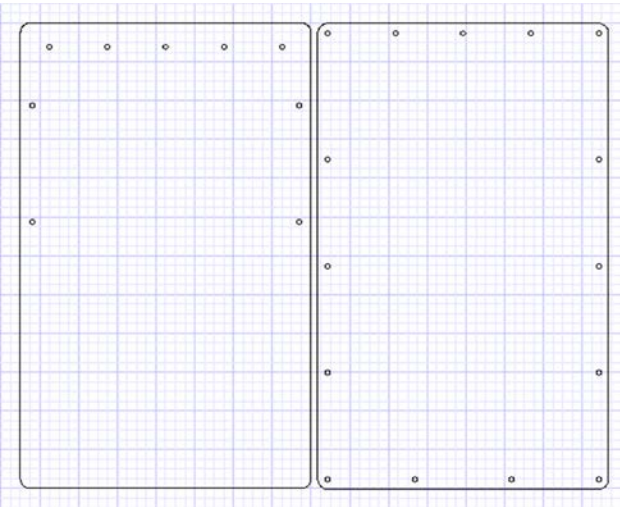
FRAME

After research, I found two ways to build and connect the frame. These were:

- Using rebate joints
- Using butt joints with internal corner braces
- Using dovetail joints

Although I have not seen any Cajónes with finger joints, I like the look of them, and so plan to test them out to see if it would be possible to use them.

I found that while the sides should be glued together, it is important that the tapa is screwed – it can either be countersunk or the screw heads can sit on the surface. This is because, as can be seen in my first prototype, with a lot of playing, a glued front will come unstuck. This also allows the player to adjust the screws, modifying the sound, as well as remove the tapa if adjustment inside is necessary. However, it is also important that the screws are positioned in precise places. I have identified two arrangements of screws, and will need to test to determine the best one.



Two types of screw placement of professionally made Cajónes

DIMENSIONS

I researched the dimensions of Cajónes, and found three standard sizes: 18" x 13" x 13", 18" x 12" x 12" and 19" x 12" x 12". Through research at *allans billy hyde*, I found that although generally the size of the Cajón does not greatly affect the sound, larger ones generally sound more wholesome. I decided to use metric measurements as Australia uses the metric system, and it will make it easier to design and cut the pieces of wood. I decided to round off the 19" x 12" x 12" dimensions to the size of 480mm x 300mm x 300mm. Conveniently this size will fit into production Cajón bags.

TYPES OF WOOD

My research showed that 12mm plywood is standard for the top, sides and back of the Cajón. This wood should be heavy and strong. For the tapa, 3-4mm plywood is the most common. However, in some designs the back is also made from 3-4mm plywood. For this reason I plan to experiment using different thicknesses of back.

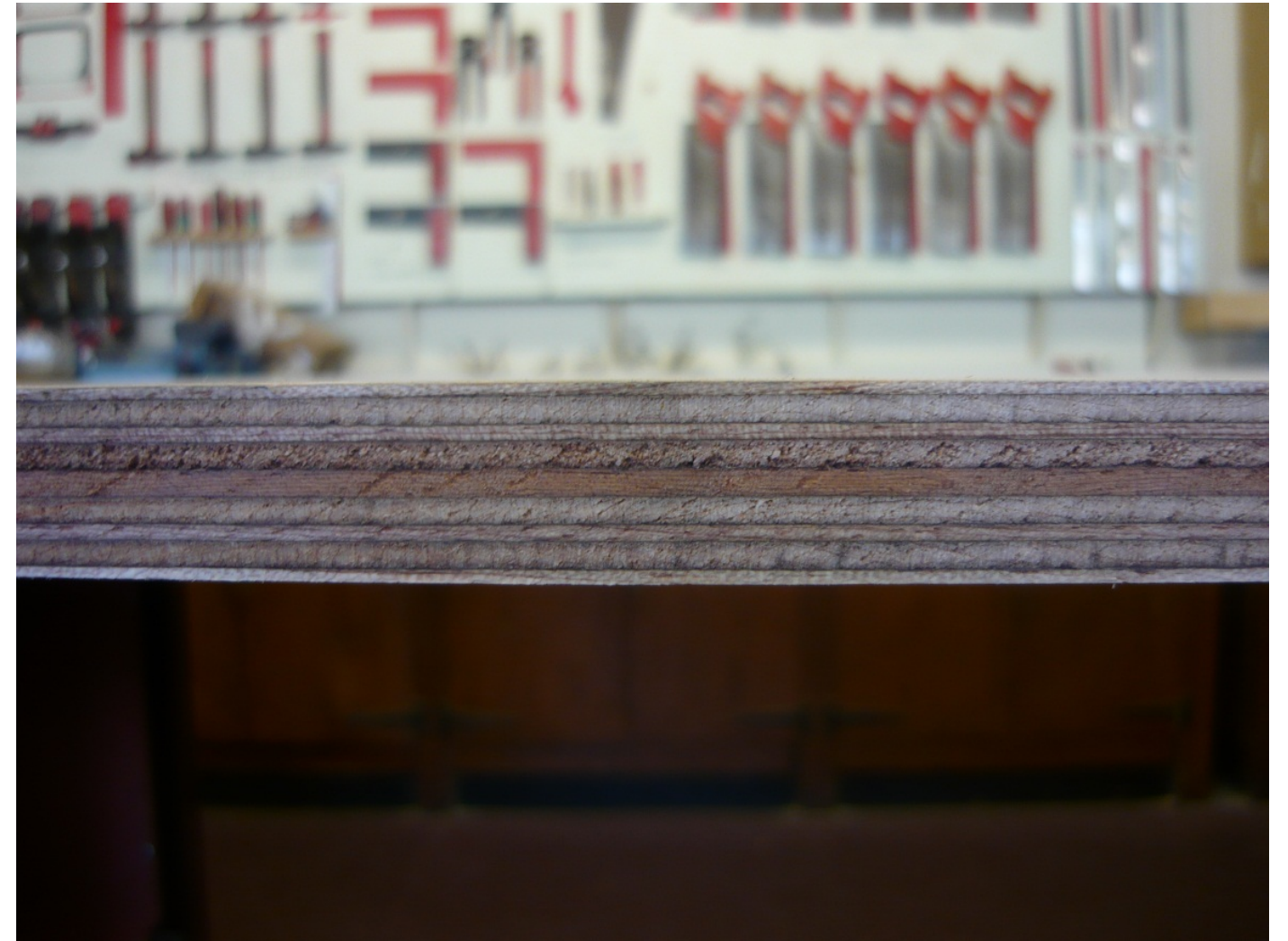
In terms of picking wood to test for the tapa, my research has found that a bendable wood is best – if the wood is too solid it will not vibrate and create a good sound. It should be light but strong. My research has also found that for the plywood that I use, A grade will be necessary for the outside surface – while the smoothness of the inside surfaces does affect the sound produced, the difference will only be noticed with poor grade wood.

In trying to find materials for my final design, I came into contact with a man who designs and builds Cajónes called RockBoxes. He gave me some useful advice to improve my Cajón's sound, primarily that I should use 2.5mm birch aircraft plywood for the tapa, and 19mm plywood for the rest of the drum. He told me that this would improve and brighten the sound of my Cajón.

I contacted Mr Ply & Wood for a quote for this wood. The aircraft ply came in sheets of 1220 x 1220, however the minimum sheet size for the 19mm plywood was 2400 x 1200. The quote came to \$400 not including delivery, and although it was expensive, I believed that it was worth it and so I ordered it. It arrived, and I asked Mr Ply & Wood to cut the larger sheet in half so that I could fit it in my car. Then when I went to pick it up, they tested if it would fit using a different piece of wood, and unfortunately it would not. Luckily they had not cut it in half, and offered to deliver it to my school for an extra charge of \$29.

The final price of the wood including delivery was \$406.56.

EVALUATION: I was uncertain exactly how what I had ordered would look, and once seeing it, was very happy. The 2.5mm plywood was very light and had very nice grain in it which I would be able to highlight with lacquer, and the 19mm was a great pinky-brown colour, also with very nice grain.




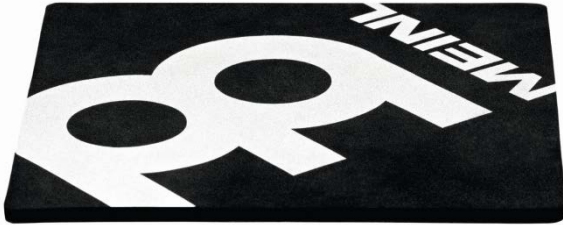
FINISHES

I have found that other than the tapa, the finish on the Cajón will not affect the sound of the Cajón. I plan to use a stain to change the wood colour of the box. I will then use a polypropylene lacquer and wax to finish it to a semi-glossy or satin finish. For the tapa on the other hand, as it is supposed to vibrate, putting a hard finish on it is a bad idea. According to my research, the only safe way to finish the tapa is using oil such as Tung Oil. This will protect the wood while not affecting the sound. Using a prototype, I plan to determine the best finish to use.

CUSHION/PAD

After research, I found a number of cheap Cajón pads for sale, ranging from \$4 to \$10. I plan to conduct an observation survey on a number of these, firstly to determine if they add any advantage to the Cajón, and secondly to determine the optimal size and material. If they do add an advantage, I will then recreate one myself, using the laser cutter to cut the edges. I will possibly use an adhesive to attach the pad to the top of the Cajón.

Two Cajón pads I found:

Schlagwerk Cajón Pad	Meinl CAJPAD Cajón Pad - Black
	
Price: \$9.95	Price: £4.20

I have seen some bad reviews about the Meinl Cajón pad. One reviewer said:

I bought this for my Cajón but was disappointed when it finally arrived. As described in the title of this review, this is nothing more than a slightly bigger mousepad. It doesn't really provide that much cushion. Don't waste your money on this item.

-- caseyrebel "caveat emptor"

This review leads me to believe that it may not be necessary to make a pad for my Cajón. I tested this by sitting on several Cajónes with pads, and comparing them to Cajónes without. I found that the pad did not improve the sound of the Cajón, nor how comfortable it was. For this reason, I have chosen not to make one.

LOGO

I have decided to include a logo on the front face of the tapa, similar to many other brands of Cajónes. I will use a laser engraver to engrave the logo on the wood. I decided to use a lowercase jw for my logo. After looking through many fonts, I decided to use the font aaaiight! as I like the look of it. The logo will look like

this: 

I decided to test the logo design on a spare piece of plywood that I had from a prototype. This can be seen in the Laser Engraving prototype on page 19.

SNARES AND STRINGS

There are two ways to add the buzz sound to the Cajón:

STRINGS

A ‘strings’ Cajón uses guitar strings, either tensioned from the centre top to the bottom corners, or the centre top to the centre sides of the frame inside the tapa. By using multiple strings, a vibrating snare sound can be created.

To allow the snare to be adjustable, there is only really one way using strings. This involves connecting the strings to a ‘floating bar’, which is pulled to the base of the Cajón with either strings or bolts – to adjust the tension on the Cajón. This is not a good design, as it cannot be adjusted while playing the Cajón. For this reason, I am unable to use strings, as this means that the Cajón will not comply with the design brief.

SNARES

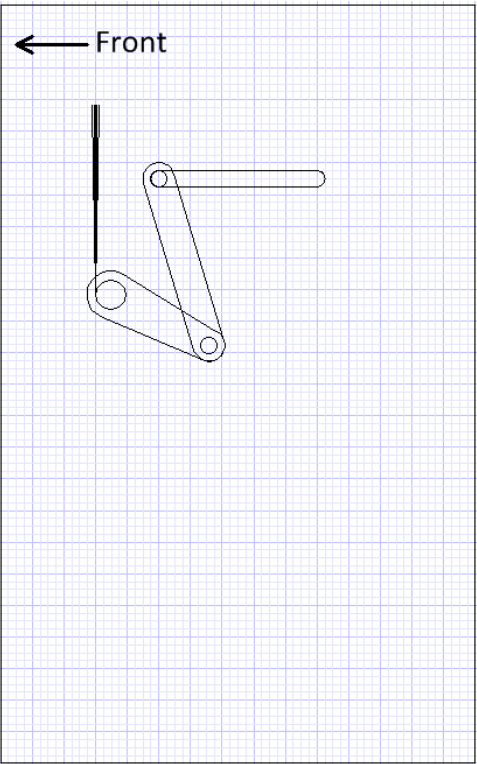
A snares Cajón uses snare drum snares mounted on a piece of wood or dowel, which rest against the tapa to generate the buzz sound. Generally, a standard snare drum snare is cut in half, and the two pieces are used together to maximize the area of the snare. Snare Cajónes are much more flexible and allow for an adjustable snare. There are three ways to do this:

Foot Pedal	Small (Stationary) Knob	Moving Wing Nut or Knob
		
This allows the player to adjust the snare while they are playing without moving their hands. A pedal means, however, that the drum is an odd size. If this were to be used, the pedal would need to be easily removable when storing the Cajón.	This allows the player to adjust the snare while they are playing using only one hand – to twist the knob. This setup does however mean that the Cajón can be stored without having to remove anything.	This is a very easy method to adjust and tighten, but is more difficult to use while playing. This setup does mean that the Cajón can be stored without having to remove anything.

Using these different ways as guidelines, I plan to devise my own way to make an adjustable snare.

SNARE MECHANISM

I based my snare mechanism on the moving wing nut design above. I modified this design to allow the player to adjust the snares while playing – by having the slot horizontal rather than vertical; it removes gravity from the equation, and so is changeable from ‘snares on’ to ‘snares off’ without actually tightening the wing nut. Using this lever mechanism means that pulling the bolt back (right) turns the dowel clockwise, releasing the snares, and pushing it forward (left) turns the dowel anti-clockwise, engaging the snares.



The outside of the Cajón will remain with a slit in it, in which the bolt is able to move back and forth. A knob needs to be installed on the outside of the Cajón to tighten the bolt. Although there are plenty of threaded knobs available for purchase, I wish to use a wooden knob, and so will have to make it using a lathe. I plan to knock-in and glue a threaded insert into the knob, so that it is able to tighten the bolt.

I have found that using the above design, when the snare is off, it still vibrates inside the drum. For this reason, I need to staple a piece of felt behind the snares, so that when they are off, they will rest on the felt and will not vibrate.

During the construction of the Cajón, I decided to modify the share mechanism. By changing it from a linear motion to a rotational motion, I was able to reduce moving parts, and thus reduce rattling. This process is further described in the construction section.

BUYING SNARES

After researching snares, I found that there were many different types – what was the difference between them all? I couldn't tell. I needed to talk to an expert about them to find out which ones would sound the best in my Cajón. I emailed Optimum Percussion, a percussion shop based in Burwood, to query some information about snares in Cajónes. In my email, I asked what the difference between different snares was. The following is their reply.

On a snare drum, better snares like the pure sound or black swamp spiral snares are better sounding then the sub\$10 standard snares... but this is different to a Cajón. The snare drum is all about the evenness of the tension and the number of points in surface contact with the head as well as the material used- none of this applies to a Cajón. I am afraid you will have to try a few to find out. We have a number of different options in stock.

Allan
Optimum Percussion
19/12/2011






From this, I decided that it would be necessary to test a few different snares to determine the one which sounded best. I decided that I would buy three 'different types' and test them to see which performed the best. The range at Optimum Percussion appeared to be rather small, so I looked at another store that sells percussion, *allans billy hyde*. I found three different snares to test:

Puresound T1420 14" Twisted Series Snare Wires	Pearl Drums Snare Wire - SN1442I	Pearl Drums Snare Wire - S022
 <ul style="list-style-type: none">• 40 strands twisted in 20 sets• 14 inch	 <ul style="list-style-type: none">• 42 strands• 14 inch• Ultra-Sound• I –type• W/strap & cord	 <ul style="list-style-type: none">• 20 strands• 14 Inch• High Carbon Steel• Straps
Price: \$54.99	Price: \$59.95	Price: \$14.99

From my research I decided to test these three different types of snares and experiment to find my preferred sound. Please see (Prototype 1).

MICROPHONES

There are five main ways to pick up the sound generated by the Cajón.

Name	Type	Description	Price
B-BAND UKKO Cajón A1.2C-DST 	Dynamic	Mount: Internal Wall Preamp: Yes, 1.2A Output: Embedded TS This system appears to be the most appropriate as the preamp should allow for the signal to be sent straight to the effects unit. A low impedance to high impedance converter may be necessary however, as the effects are built for guitar pickups and not for microphones. Powered by a 9v battery. The jack acts as a switch to turn the system on when a plug is inserted.	\$199.95 (AUS)
Kopf Internal Microphone System 	Unknown	Mount: Floating Gooseneck Preamp: Unknown – has battery for power Output: Embedded TS As the microphone is on a gooseneck, it is possible to change the direction that it is facing, affecting the sound. Powered by a single AA battery. The jack acts as a switch to turn the system on when a plug is inserted. I decided not to use this, as it is only powered by one AA battery, and so would likely not have the output gain required to use guitar pedals.	\$99 (USD)
Schlagwerk Cajomic CMIC 90 	Dynamic	Mount: Internal Wall Preamp: No Output: XLR The microphone is freely suspended in the centre of the sound hole, stopping vibrations. Can be connected to a low-frequency amp or through a mixer. Requires the back panel thickness to be less than 5.5mm. It is a passive system, meaning it requires no power to work. As the system is capable of going through an amp, it appears that it may work with effects, but would require an XLR to 6.35mm adaptor, and possibly an impedance switcher. I would have to test that this would work before buying one.	\$179 (AUS)
LP Cajón Mic System with either Shure Beta 91A or Audix ADX60 	Condenser	Mount: External Rear Wall Preamp: No Output: XLR (Beta 91A) or Mini XLR (ADX60) This system does not comply with the design brief – it is not internal. Therefore, it will not be used.	\$268 (ADX60) \$265 (Beta 91A) (USD)
Any microphone 	Varies	Mount: Microphone Stand Preamp: No Output: XLR (probably) This system does not comply with the design brief – it is not internal. Therefore, it will not be used.	Varies

From this research I decided to test the B-BAND UKKO Cajón A1.2C-DST microphone, and decide on whether I was happy with the sound. I chose this because it fits into the Cajón internally, and so looks the best. If I was not happy with the sound, then I would have proceeded to test the Schlagwerk Cajomic CMIC 90. Unfortunately, due to the unavailability of the B-BAND microphone in retail in Australia, I had to buy to test it.

I was directed by B-BAND, the maker of the Internal DST microphone, to a distributor in Australia. I called the distributor, Dominant Music, from whom I received a quote of \$197.95. I decided to email many retailers in attempt to find one that would sell the microphone for cheaper than that – the quote was very expensive compared to some international online prices. However, I did not find any retailers who were able to ship it to Australia for less than that price. I decided to buy it through Optimum Percussion, a percussion retailer based in Burwood, Sydney, as this would be easier and faster. The final price was \$199.95.

EFFECTS

I visited Turramurra Music, a local music shop, to test effects pedals with my Cajón. I tested effects such as distortion, overdrive, phaser, compression, chorus, reverb, tremolo, wah-wah and delay. I found that reverb and delay were the only two that sounded good, and they sounded very good together. In the shop, the two pedals I was using were the Boss Digital Delay DD-3 (priced at \$155) and the Boss Digital Reverb RV-5 (priced at \$175).

These two pedals combined were very expensive, and I thought there must be a better solution. I did some research on the internet, and found the Behringer Digital Reverb/Delay DR-400 pedal (priced at \$65).This pedal is suitable, as it compactly combines both delay and reverb, using only four knobs for both effects. This means that it has a small footprint on the inside of the Cajón, and will be easier to disassemble and desolder. Due to the very low price of this pedal, I decided I would buy it to test and if I didn't like it, I could resell it.

When it arrived, I tested it, and in my opinion it sounded as good as the more expensive Boss pedals combined. I then started the process of removing the components from the circuit board so that I was able to use them on my Cajón. This process can be followed in the Cajón prototype.

Boss Digital Delay DD-3

The image shows a Boss Digital Delay DD-3 pedal. It is a silver and black unit with a black footswitch. The top panel features the 'Boss' logo, 'Digital Delay DD-3' text, and input/output jacks labeled 'INPUT' and 'OUTPUT'. On the right side, there are four blue knobs: 'E.LEVEL' (with MIN and MAX markings), 'F.BACK' (with MIN and MAX markings), 'D.TIME' (with a scale from 1 to 100), and 'MODE' (with a switch for 'L. 800ms' and 'H. 200ms'). A 'CHECK' indicator light is located between the second and third knobs. A 'HOLD' button is at the bottom right.

Price: \$155

Boss Digital Reverb RV-5

The image shows a Boss Digital Reverb RV-5 pedal. It is a black unit with a black footswitch. The top panel features the 'Boss' logo, 'Digital Reverb RV-5' text, and input/output jacks labeled 'INPUT A (MONO)' and 'OUTPUT B (MONO)'. On the right side, there are four black knobs: 'E.LEVEL' (with MIN and MAX markings), 'TONE' (with MIN and MAX markings), 'TIME' (with a scale from 1 to 100), and 'MODE' (with a switch for 'SPRING', 'PLATE', and 'ROOM'). A 'CHECK' indicator light is located between the second and third knobs. A 'MODULATE' button is at the bottom right.

Price: \$175

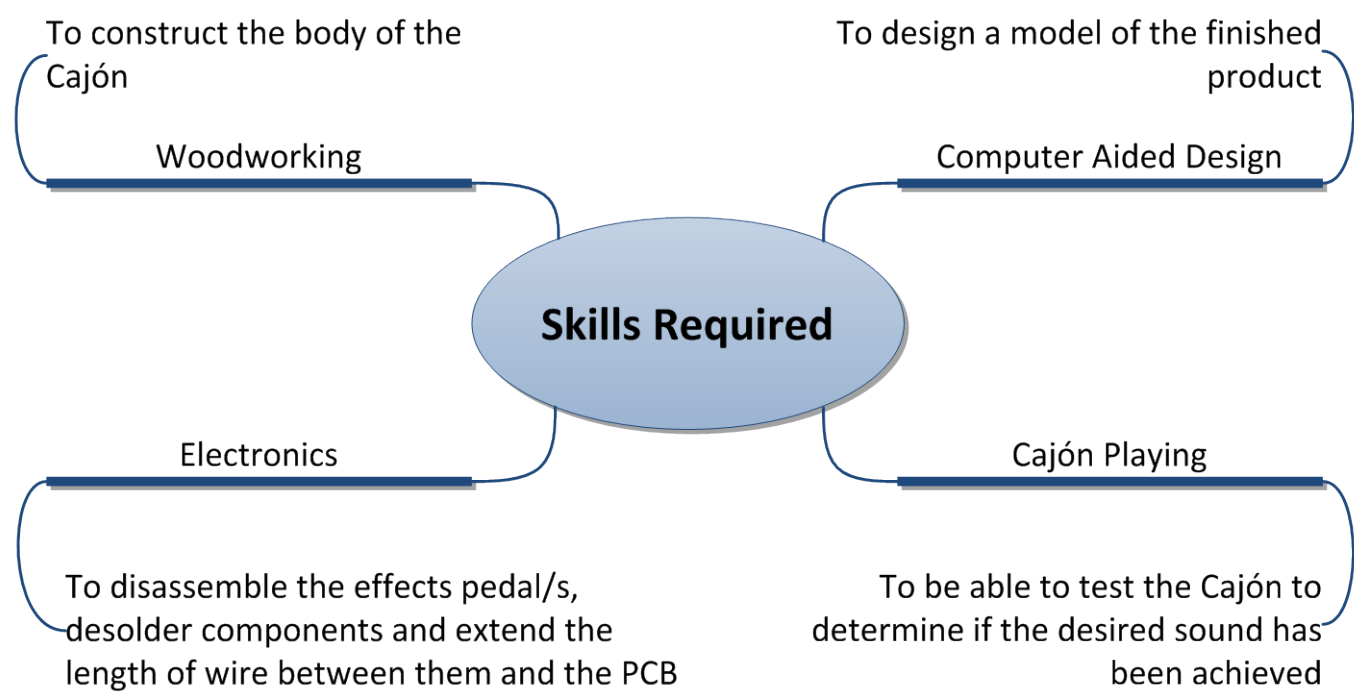
Behringer Digital Reverb/Delay DR400

The image shows a Behringer Digital Reverb/Delay DR400 pedal. It is a silver and black unit with a black footswitch. The top panel features the 'Behringer' logo, 'DIGITAL REVERB / DELAY', and 'DR400' text. On the right side, there are four black knobs: 'BALANCE' (with DIR and FX markings), 'TONE' (with REV and REVERB markings), 'R.TIME' (with a scale from 1 to 10), and 'D.TIME' (with a scale from 1 to 10). A 'MODE' switch is at the bottom right, with positions for 'REV' and 'REVERB'. A 'SET TEMPO: PRESS & HOLD -> 2 SEC (DELAY)' instruction is at the bottom.

Price: \$65

SKILLS

I brainstormed the skills I will require to complete the major design project.



SAFETY

It was necessary to be trained in any tools used before beginning the work. I was not allowed to use the track saw as it was banned for students to use due to its potential danger. Additionally, my teacher does not let students use the drop saw for the same reason. Although I was already practised in the use of some tools, I was taught how to use the other tools.

PRACTISED TOOLS

- Scroll Saw
- Tenon Saw
- Drill Press
- Portable Drill
- Soldering Iron
- Laser Cutter
- Pliers / Wire Cutters

UNPRACTISED TOOLS

- Drum Sander
- Trim Router

DISALLOWED TOOLS

- Track Saw
- Drop Saw

Of course, when using tools, it is important to wear personal protective equipment.

PERSONAL PROTECTIVE EQUIPMENT

- Safety Glasses
- Ear Protection
- Leather Shoes

Although personal protective equipment was not necessary to use the laser cutter as there is a protective shielding to prevent accidental damage, it was important that I left the room containing the laser engraver while it cut, so that I would not be able to inhale fine particles of wood and/or plastic.

PPE was also necessary when lacquering my project. After referring to the Material Safety Data Sheet, I decided to use both a dust mask as well as eye protection.

EVIDENCE OF CREATIVITY

IDEA GENERATION

Idea Generation is covered in the Research, Experimentation and Applications of Conclusions section which can be found on Page 6.

DEGREE OF DIFFERENCE

TESTING OF CAJÓNES AT ALLANS BILLY HYDE

I visited *allans billy hyde Drumcraft* in Surry Hills, an *allans billy hyde* store specifically for drums, to test various parts of the Cajónes they had in stock. By doing this, I was able to compare several commercially available Cajónes to the Cajón intended to produce.

I took photos of the insides of them through the sound hole, and then merged them using Photoshop.

I observed:





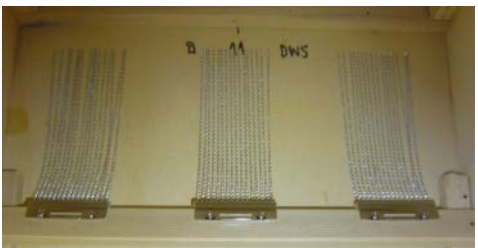
- Snare mechanism
- Screw placement
- Feet
- Sound hole
- Body material



This research of commercially manufactured Cajónes aided me in the process of constructing my own Cajón. As there are no commercially manufactured Cajónes with effects built in, I was unable to test 'Cajón effects'.

It was difficult to determine the processes used to construct commercially manufactured Cajónes, as so many different processes are used depending on the manufacturer and type of Cajón.

- On Cajónes 1, 3 and 4 (see table), wood was used to construct the Cajón. It is unknown which type of joints was used, although it is likely that butt joints or rebate joints were used. Cajónes 2 and 5 were both primarily manufactured from plastic. Although it is unknown in which way these were constructed, one could assume that they were moulded.
 - My Cajón uses mitre joints to connect all sides but the tapa. A butt joint is used for the tapa.
- On Cajónes 2,3, 4 and 5 (see table), standard screw placement was used, and a round sound hole was placed in the back of the Cajón. On Cajón 1, the front was glued and the sound hole was in the left hand side.
 - My Cajón uses standard screw placement, and has a round sound hole in the back.
- Because of the snare mechanism in my Cajón, I needed to use a router to cut a slit in the side of my Cajón, drill holes in each side and insert a rotary mechanism to adjust the snares. Although this exact process would not have been necessary on the tested Cajónes, a similar process would have been necessary to create the ability to adjust the snare (on those with adjustable snares).
- My Cajón has inbuilt effects. This means that my project involved many processes that would not be involved in manufacturing the tested Cajónes. These processes include:
 - Desoldering a guitar effects pedal - if my Cajón was to be mass produced, a custom printed circuit board would be created to be used, and thus this desoldering process would not be necessary
 - Engraving the back plate
 - Routing the inside and outside of the back panel to fit the back plate so it is flush with the outside
 - Gluing the back plate to the Cajón
 - Screwing the electronics to the inside of the Cajón

Name	1. Pratley CJ02 Cajón Performer	2. Latin Percussion LP1432 Cajón Exotic Drum	3. Meinl Headliner Cajón Natural Bigger	4. Meinl Bass Pedal Cajón	5. Latin Percussion LPA1332DWS Aspire Accent Cajón Dark Wood Stain	My Cajón
Pickup	Yes	No	No	No	No	Yes
Mechanism	Snares – mounted long ways on the right hand side of the tapa. Adjustable by pulling on rope – difficult to do while playing. Easily adjustable while not playing.	Strings – two attached from corners of the frame at the top to an adjustable (from bottom with drum key) sliding block attached to the bottom.	Strings – four attached from corners of the frame at the top to an adjustable (from bottom with drum key) sliding block attached to the bottom.	Snares – One large set of snares adjustable via a foot pedal on the left hand side. Although the snare is adjustable, it is only really controllable on or off.	Snares – three half-sets of snares screwed into a triangular bar mounted 1/3 from the top of the Cajón.	Snares – half of a full size snare attached to a rotating dowel. This can be controlled while playing.
Sound Hole	Round on Left	Round on Rear				
Feet	4 x Rubber	2 x Adjustable length (non-levelling) feet on the front 2 x rubber on back	4 x Large rubber	4 x Large rubber	4 x Large rubber	4 x Large rubber
Screw Placement	Glued	Standard: 5 at the top, 4 at the bottom, 3 (lower) each side				
Body	Wooden	Plastic body with wooden tapa.	Wooden - hard glossy finish	Wooden - hard gloss finish – nice looking tapa wood	Plastic body with “Dark Wood Stain” on it	Modified standard (with 5 at the bottom) Cedar/Birch with clear finish
Notes	Placement of snares on right means sound was uneven whilst playing in the middle.	Minimal difference between the bass note and the top note – both had a fair amount of snare and the resonance and tone was similar between them.	Good sound but strings too tight – probably adjusting strings would fix that. Good difference between base note and top note – higher sound with less resonance at the top, lower note and more resonance on the bottom.	Good high note but lots of snare on the bass note as well. Bigger size produced a lower bass tone. There was a small 3mm foam pad glued to the top, which did not make the Cajón any more comfortable to sit on.	Good difference between bass note and high note due to the placement of snares.	
Price	\$449	\$259	\$249.99	\$499.99	\$249	\$Unknown
Picture						(Completed Snare Mechanism)

* LP stands for Latin Percussion

**Standard screw placement: 5 at the top, 3 (lower) each side and 4 on bottom.

EXPLORATION OF EXISTING IDEAS

Exploration of existing ideas is covered in the Research, Experimentation and Applications of Conclusions section which can be found on Page 6.

IDENTIFICATION AND JUSTIFICATION OF IDEAS AND RESOURCES USED

Identification and Justification of Ideas and Resources used is covered in the Research, Experimentation and Applications of Conclusions section which can be found on Page6.

CONSIDERATION OF DESIGN FACTORS

APPROPRIATENESS OF THE DESIGN SOLUTION

The product must be suitable for the environment in which it will be used.

- Large rubber feet are used to isolate the sound of the Cajón from the surface it is sitting on, to stop it from moving while playing, and to prevent damage. This is important, as the Cajón would often be used at outdoor events where the ground could be damaging without feet.
- A waterproof finish is used on the Cajón to protect it from water, and allow dirt to be washed off. Again, this is necessary as the Cajón will likely be played outside.

NEEDS

- The product must fulfil the needs for a Cajón with digital effects that are identified in the Criteria to Evaluate Success section, which can be found on Page 3.

FUNCTION

- The product will need to be played and sound similar to commercially available Cajónes.
 - It should produce a high note when hit at the top of the tapa, and a low note when hit closer to the bottom of the tapa.
 - There needs to be a snare mechanism which allows the player to turn snares on and off while they are playing.
- The effects must be integrated into the product.
- They must modify the sound produced by the Cajón
- The Cajón must be of similar size to commercially available Cajónes. This is necessary to allow it to fit in commercially manufactured Cajón bags.

AESTHETICS

- The completed product needs to look appealing, and be aesthetically pleasing, with little to no aesthetic flaws
- The Cajón must be unique in design. It must look different to mass-produced Cajónes, and have unique aesthetic features that cannot be found on any other Cajón.

FINANCE

- If the Cajón were to be commercially manufactured, it would be significantly cheaper than the cost of this project. This is because:
 - The materials would be bought in bulk at wholesale prices
 - The effects circuit board could be custom designed to specifically fit inside the Cajón

This would drastically decrease the price of the product.

ERGONOMICS

Ergonomics need to be considered when deciding on the height of the Cajón. Although for my project, the height was dictated by the standard size of Cajónes and Cajón bags, it is also important to ensure that both the high and the bass note can be hit without strain to the player.

OCCUPATIONAL HEALTH AND SAFETY

When constructing the Cajón, occupational health and safety was important to ensure that I was not injured by machinery or chemicals. This is further explored in the Safety section on Page 12.

QUALITY

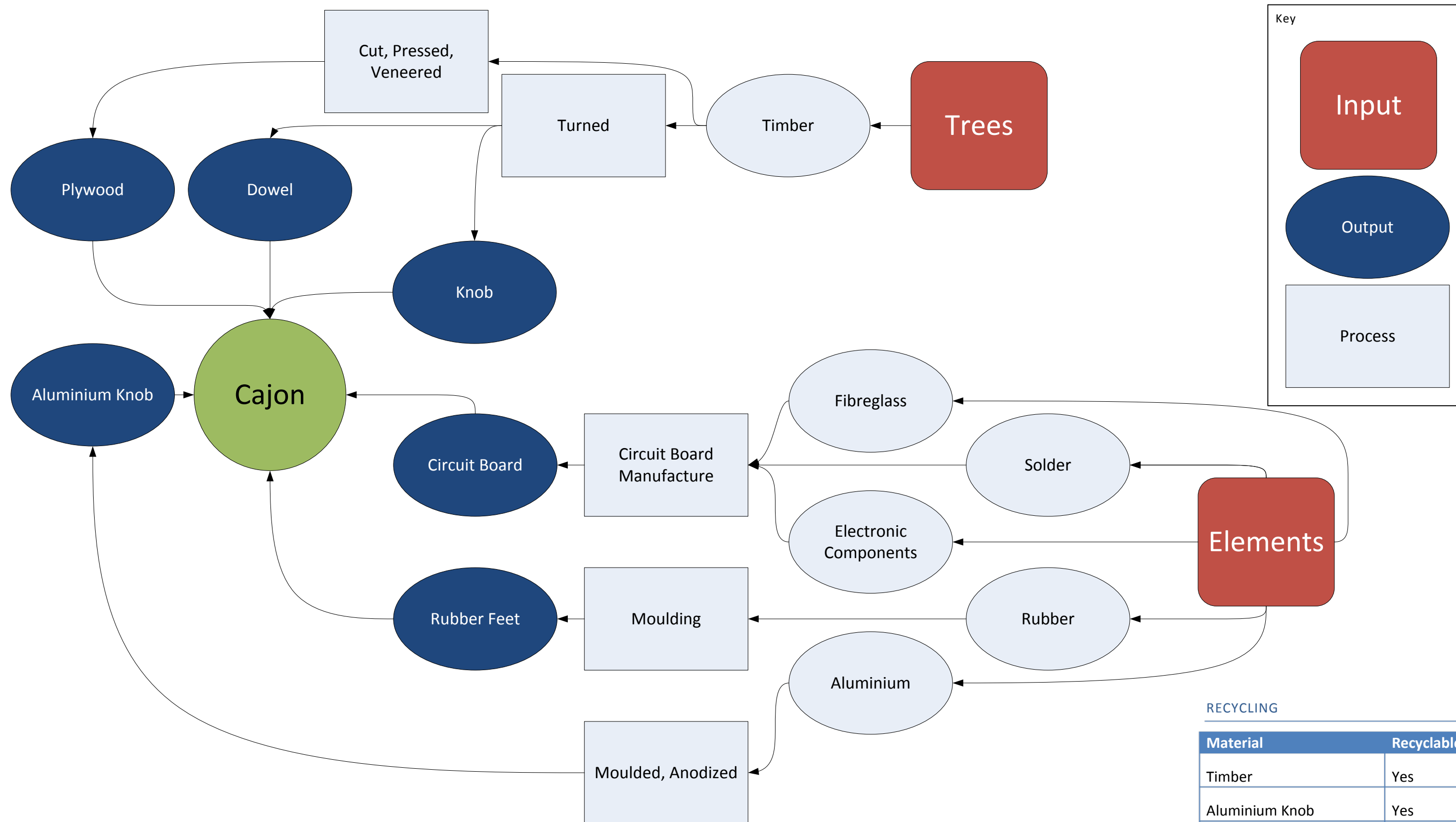
The Cajón needed to be constructed to a standard – all processes needed to be done carefully to ensure that the product was as high quality as possible, without any defects or flaws.

SHORT-TERM AND LONG-TERM ENVIRONMENTAL CONSEQUENCES

As the project uses timber, several different trees have been used to produce the different types of plywood and the wood used for the snare mechanism. However, it is likely that the non-veneered plies of the plywood were plantation grown, and the project used a minute amount of wood itself in comparison to several whole trees. Although the veneers, Birch and Cedar, are likely to have been removed from non-plantation trees, they are so thin that thousands of metres of timber could have been veneered from one tree, and so remain a very minimal environmental impact. For this reason, I believe that, although there may be short term environmental consequences, i.e. the loss of several trees, there are very minimal long term consequences.

OBSOLESCENCE

Although I did not want the product to become obsolete faster than a commercially manufactured and purchased Cajón, I believe that the electronics will limit the product's lifespan. It is likely that commercially bought Cajónes could last up to 20 years if treated well, and the acoustic Cajón should last this time too. I do not think that the effects will last more than several years, as they were cheap, and thus likely to be low quality.



RECYCLING

Material	Recyclable
Timber	Yes
Aluminium Knob	Yes
Printed Circuit Board	No
Rubber Feet	Yes
Metal Screws and Snare	Yes

CAJÓN

I decided to build a preliminary prototype so that I was able to evaluate the design of the Cajón, and conduct some testing on it. I decided to use butt joints as they were quick and easy. I also decided to screw the back on, and glue the front, as I intend to use the prototype to test the snare mechanism, and a removable back would make this easier.

STEPS FOR CONSTRUCTION

1. I began by marking out:

Top and Bottom: 2 x 300 x 300 (12mm Plywood)

Sides: 2 x 480 x 300 (12mm Plywood)

Front and Back: 2 x 505 x 300 (3mm Plywood)

My teacher then used a track saw to cut these pieces. I was not allowed to use the track saw because of the ban of student use of portable circular saws.

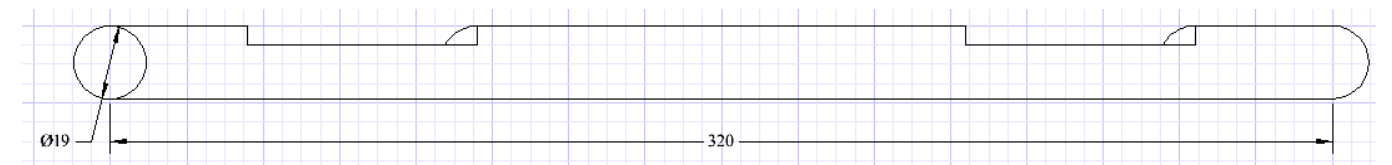
Unfortunately however, due to the size of the pieces of wood I had purchased and the width of the saw blade, top, front, bottom and back ended up being 5mm smaller width-ways. In addition to this, although I had intended my prototype to be 480 x 300 x 300, due to my miscalculation, it ended up being 500mm high.

I drilled the sound hole using a 92mm hole saw, as it was the largest hole saw available to me. I then drilled holes for screws in the top, bottom and back, and glued and screwed these pieces together. Finally, I glued the front onto the Cajón and lightly sanded the edges.

EVALUATION: Although the Cajón worked well and made a good sound, there were many things which I needed to change for the final construction. The screws connecting the sides and front were not all countersunk evenly, and some were not straight, causing breaks in the outer layer of the plywood. The sound hole was not centred, nor was it as big as I had originally intended it to be (120mm). Because of miscalculation, I ended up with far too many holes for screws (which I did not use) in the bottom and top pieces. After some playing, the tapa started to come off – the liquid nails were not strong enough. Then, once re-glued with wood glue, this continued to happen until I made the choice to also screw on the front.



2. I drilled a 19mm hole in each side of the Cajón and a cut piece of dowel similar to the diagram below. This allowed me to screw the snares onto the dowel. I then designed and made a lever mechanism to allow the dowel to be turned through a linear push-pull of a bolt mounted in the side of the Cajón. I had to drill both sides a second time higher and closer to the tapa, as I found that the first holes were not close enough.



EVALUATION: This method proved successful and I intend to use a method similar to this for my final Cajón. In the final design, I plan to only cut the holes 6mm into the 12mm pieces of ply, so that the dowel is able to swivel, but is not viewable from the outside.

3. After some playing, I was unhappy with the different quality of sound that the Cajón produced when on different surfaces – it sounded amazing when played on the linoleum in my school's woodwork room, but bad when played on carpet. This meant that it needed feet, and although I had not purchased any for the purpose, I had some very small plastic feet that I was able to add to each corner on the bottom of the Cajón. This improved the sound when playing on different surfaces.

EVALUATION: Although these feet mildly improved the sound, there was still a big difference when playing on different surfaces. I decided that I needed to buy large rubber feet such as the ones used on other Cajónes.

4. I was also unhappy with the different sounds of the Cajón – the top 'slap' sound was too similar to the bass sound. I did some research, to find that many people had solved this problem by using a thicker piece of wood for the back. I quickly made a 12mm plywood back to test this, and found that it sounded much better with the thicker back. Once again, I did not have access to a large enough hole saw nor access to a track or table saw, and so I attempted to use a scroll saw to cut the hole and the sides for the back.

EVALUATION: Using a scroll saw to cut the hole and sides meant that the hole was not even, and the sides were not straight. However, this is unimportant as it proved that the idea worked.

5. In mid-February 2012, I was contacted by Optimum Percussion, who had imported the Cajón pickup that I wished to use. This meant that I was able to install it. Installation was fairly simple, with a small page of instructions, which said to place the microphone on the left side of the Cajón fairly close to the top and the tapa. The microphone and battery cable simply pushed into some pin headers on the inside of the main casing. I drilled two holes into the back of my Cajón for the TS output and volume control to be mounted, and attached these.



EVALUATION: At first I was unimpressed by the sound quality from the microphone, but after using a proper amplifier instead of my computer to play the sound, the quality increased.

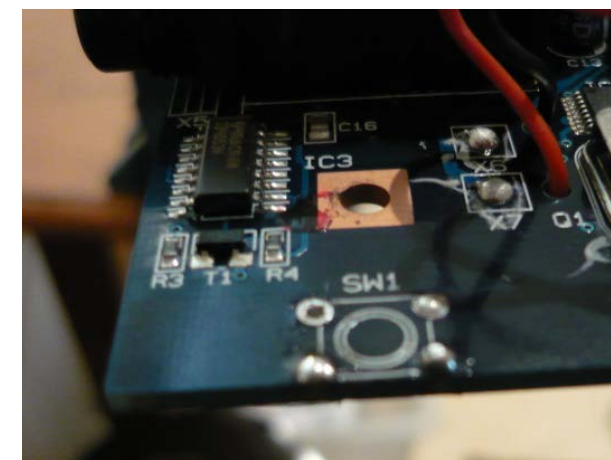
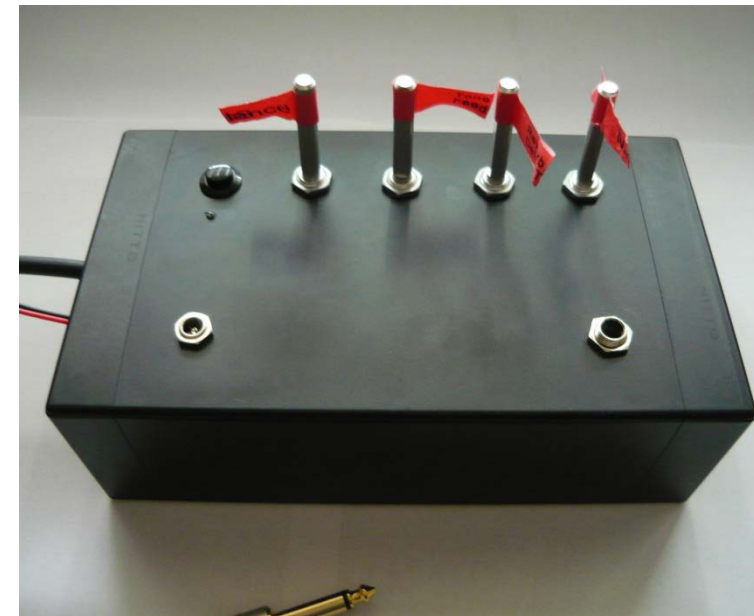
6. I decided to test the different snares that I had bought – the 40 Strand Pearl Drums Snare Wire and the Puresound Twisted Series Snare against the cheap 20 Strand Pearl Drums Snare Wire. I found that the 40 Strand Pearl Drums Snare Wire sounded the best, I believe because of its larger coverage on the top of the tapa face.
7. The glue holding the tapa to the front was not working under the pressure, having come apart twice. Not only this, but it was causing vibrations that reduced the sound quality of the Cajón. I decided to use screws to attach the tapa to the front, and by doing so, I improved the quality.

EVALUATION: For the final design, I need to find out how to better screw in screws. Because of the placement of the screws, very close to the edge, some screws removed pieces of the ply when being installed, and so reduced the aesthetic quality of the design.

8. I purchased large rubber feet, and screwed them into my Cajón using metal washers so that the screws would not pull through. This isolated the Cajón from the material it was sitting on, and improved the sound.

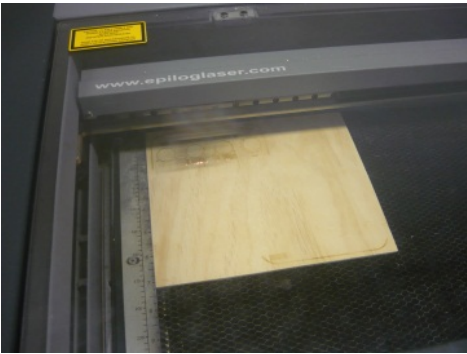


9. Having purchased an effects pedal, I began to disassemble it, de-soldering components and extending their reach using wires. This desoldering process involved heating up the solder joints, and once the solder became molten, pulling the components pins out of their holes. This was a fairly laborious task, but was necessary to allow the use of larger and better looking components.



LASER ENGRAVER TEST

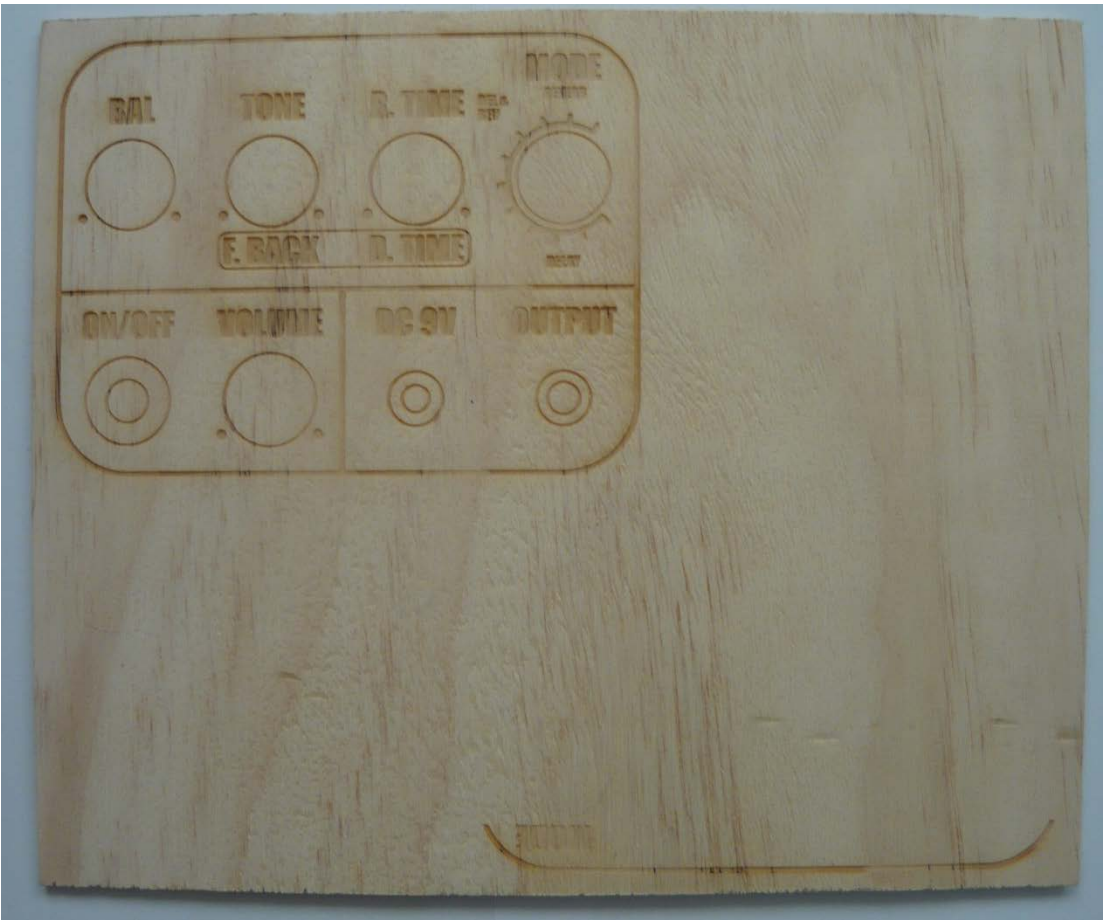
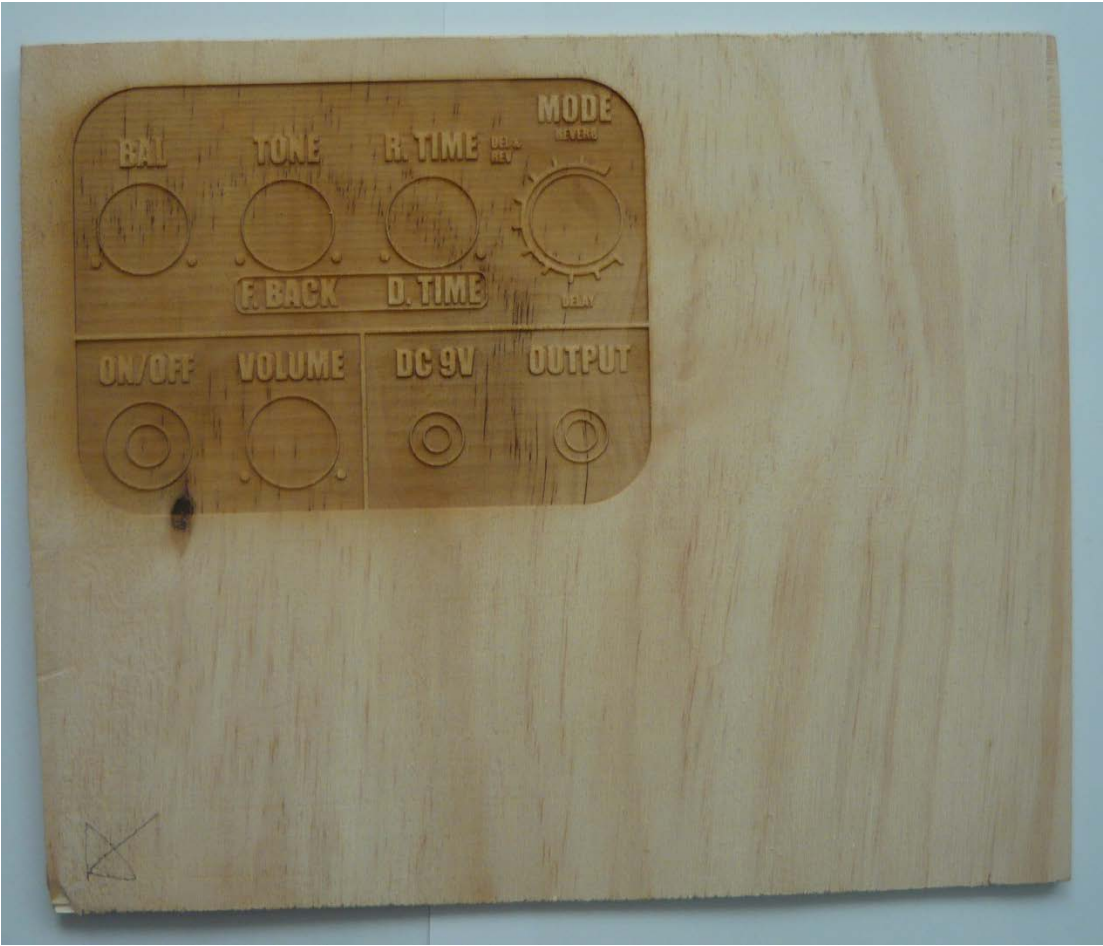
A friend of mine owns an EPILOG laser cutter and engraver and was kind enough to let me use it for this project. I decided to test the laser engraver, both for the logo and for the back plate, using a spare piece of plywood.



EVALUATION

Plus	Minus
The logo engraving was a success, and allowed me to decide how it should be engraved.	The result of engraving the back plate in wood was disappointing. It is difficult to see the text properly due to the grain of the wood. For this reason I have decided not to engrave the wood for the back plate, and to instead use a two tone plastic panel as the back plate.
Interesting	
The process allowed me to see how laser engraving and cutting worked, and determine that it was appropriate for the task of the logo on the front of the Cajón.	

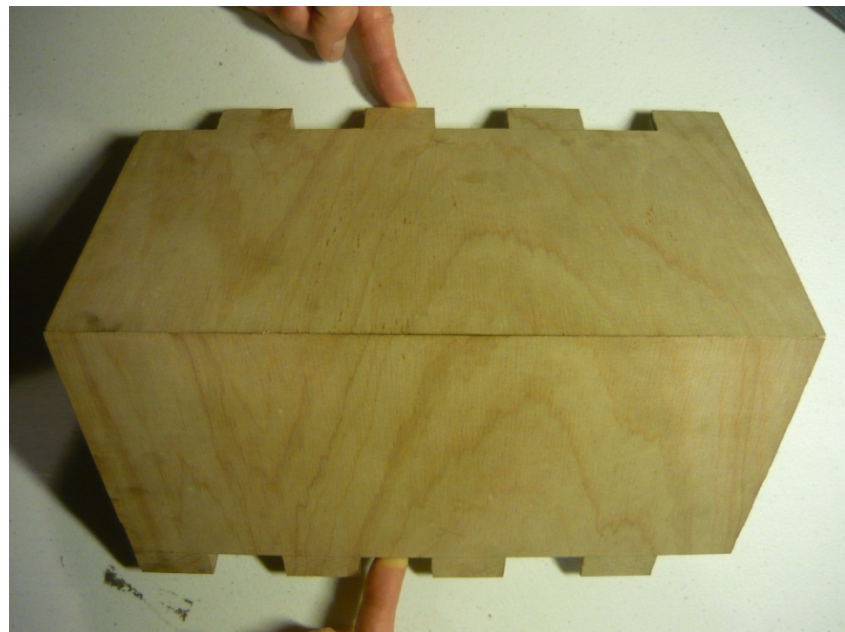
After this prototype, I conducted some investigation into laser cutting anodized aluminium. Unfortunately this was not possible using the laser cutter/engraver available to me. I have decided to use two layer plastic, as used in one of my prototypes for the final Cajón as it was easy to engrave and cut, as well as looking good.



JOINTS TEST

Using an offcut when cutting the sides of my final Cajón, I marked out and tested finger joints. I decided to test both 17.625mm fingers and 35.25mm fingers. Although I found that the 35.25mm fingers would look much better, the finger joint cutter owned by the school was unable to cut fingers this big, and so I tested using a scroll saw and a sharp chisel to cut the fingers straight. This however proved unsuccessful as I was unable to cut the fingers perfectly straight, as can be seen in the photos below.

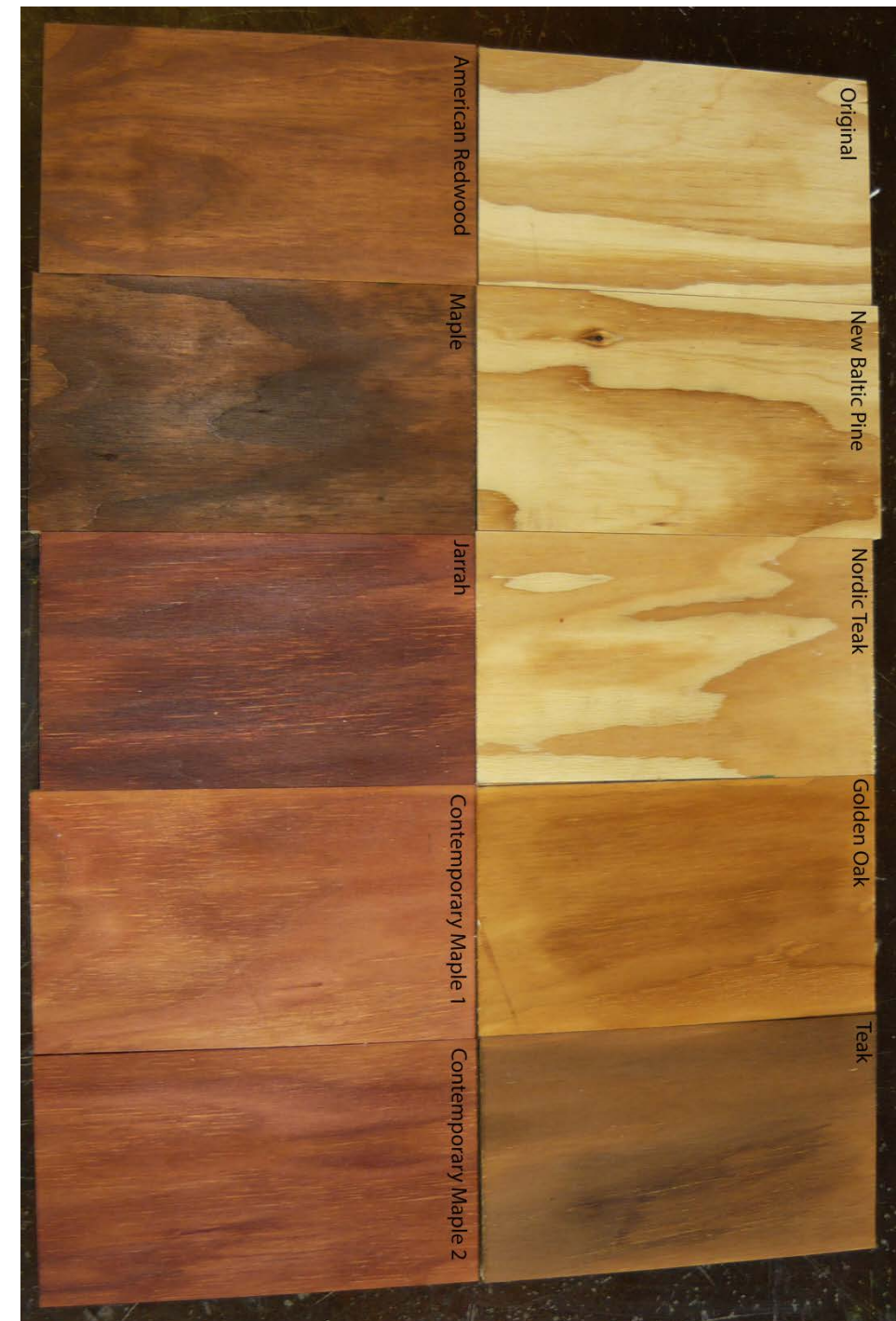
I then had the idea of using mitre joints, which would mean that it was possible for no end grain to be showing at all. I tested these by asking my teacher to cut some scrap pieces of my 19mm plywood using the track saw. This was fairly easy, but still looked good and so appeared to be the best choice.



EVALUATION: The 35.25mm fingers were totally unsuccessful – they were not straight and although they did fit together, it was not neat enough. I decided after this test that any finger joints would be very difficult and would not look good enough to use.

STAINING TEST

I decided to test different stains so I could determine how I wished my final Cajón to look. I tested nine different stains and compared them to the original wood:



EVALUATION:

I was unhappy with the result of the staining test. I did not like any of the stains enough to use them, and so decided to just use the natural colour of the wood. However, because I ended up using birch and cedar, they were still coloured and so staining would not have even been necessary.

FINAL CONSTRUCTION

The final Cajón needed to be made exactly how I want it to be. This meant that I needed to learn from the prototype regarding various issues that arose. For the final Cajón, I planned to:

- Use finger joints for the side edges, and butt joints to attach the tapa and back
- Glue all joints except for the tapa which will be screwed to the box
- Use half-width holes in each side for the snare-dowel to sit into
- Countersink the tapa screws evenly
- Make a larger and more centred sound hole
- Include the components in the rear

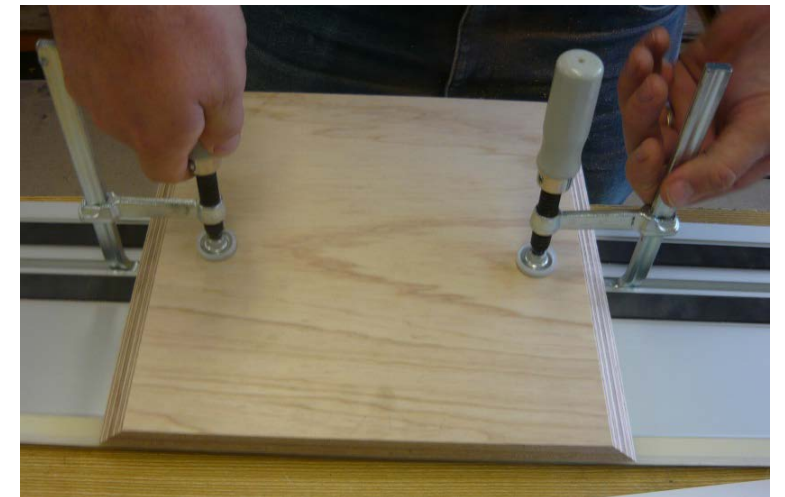
CONSTRUCTION

1. Having purchased 2.5mm and 19mm plywood, I was able to begin the final construction by marking out the wood. I began by marking out a 300 x 480 piece of the 2.5mm ply for the tapa, followed by the rest of the pieces using the 19mm ply. After marking out however, I realized that I could have marked it out better, so that the grain almost perfectly followed around the sides, the top and bottom. For this reason, I erased what I had done and marked out again.



EVALUATION: Although marking out the wood took almost three hours, I was happy with the result. I'm glad that I realized about how the grain should run before cutting it.

2. Once I had completed this, my teacher cut the wood using a track saw, which is banned for students to use. Although we could have used a table saw, moving such a heavy sheet through it would have proved difficult and may not have been as accurate. We began by sawing the long piece, before sawing each side and top from that. When sawing the long piece, it was important to clamp the track of the track saw to the wood, to prevent it from moving during the long 2.4m cut.



EVALUATION:

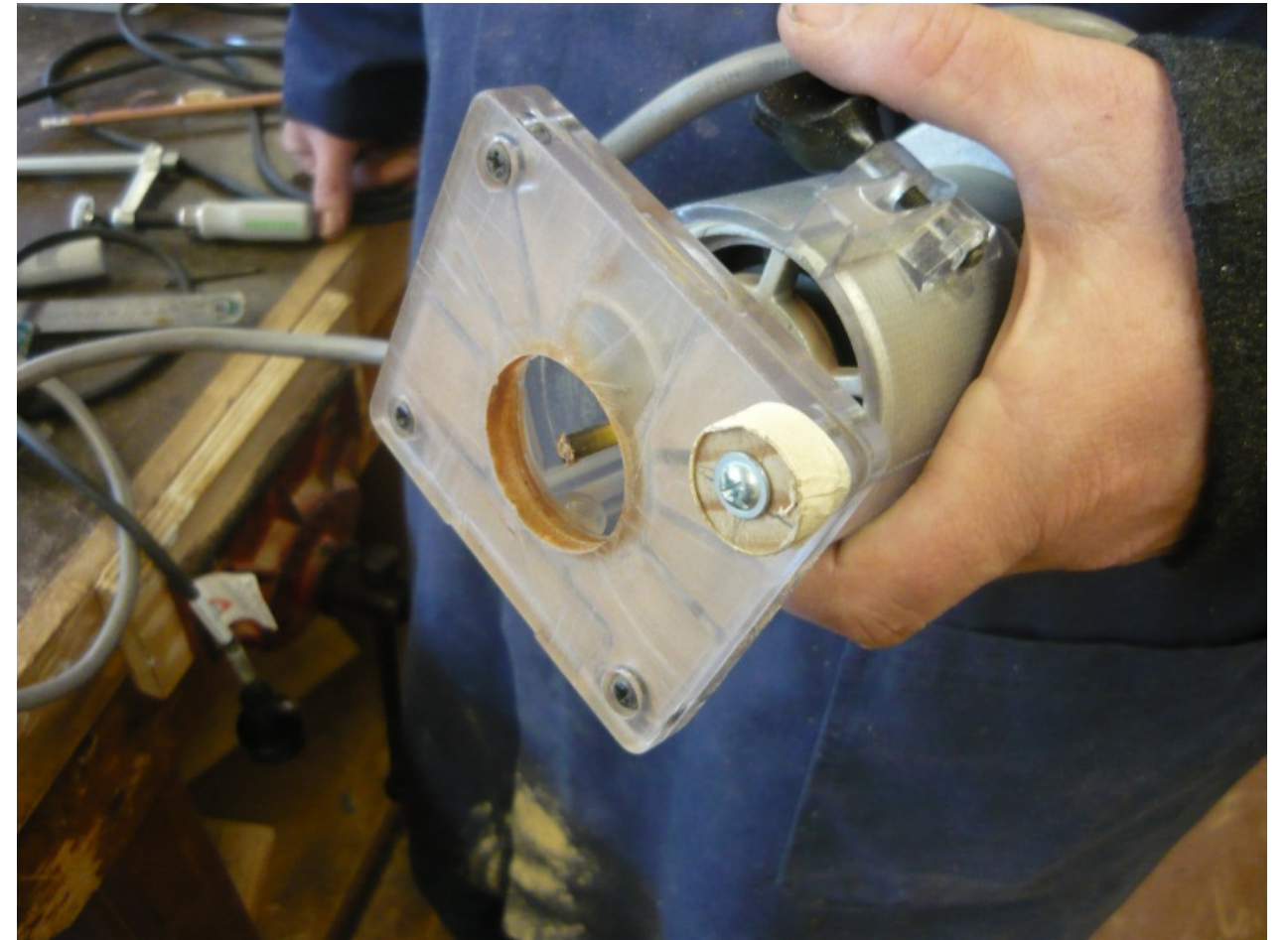
After cutting each part, I re-measured the dimensions to find that one end was about 2mm wider than the other. This means that there must have been a taper while cutting. Due to the small size of it, we kept going and hoped that it would not matter for the construction.

3. I then tested joints, as can be seen above in my joints prototype. This was necessary to determine if I was skilled enough to use finger joints, so that I would not ruin large pieces of my wood. From this I determined that mitre joints on all sides except for the tapa would be the best way to do it, meaning that there would be no end grain showing.
4. I then used a drill press with a 20mm Forstner bit to cut a 9mm deep hole in each side of the drum approximately 65mm from the front and 175mm from the top so that I could mount the 19mm dowel for the snare mechanism.



5. Using a tenon saw, I cut a piece of dowel to the correct length, and I used a drum sander to make one side of the dowel flat, to aid in mounting the snares on the dowel. Finally, I used a sanding block to ensure that this was totally flat.
6. I began building a linear slot system like I used in my prototype, when my teacher suggested that I use a rotary mechanism. This meant there would be less parts of wood inside my Cajón, reducing vibration, as well as being more aesthetically pleasing on the exterior of the drum.
7. Using a tenon saw, I cut a piece of scrap pine timber so that I could make the rotary swing part of the snare mechanism. I used a 19mm spade bit to cut a hole for the dowel.

8. I used a trim router, with a small piece of dowel screwed to the flat plate so as to route an arc in the left side of the Cajón for the snare mechanism bolt to sit in.



By using masking tape on the underside of the cut, I ensured that I would not chip the wood when cutting the arc. However, as seen in the photo below, somehow the trimmer did not completely cut the veneer from the plywood. Using a scalpel, I carefully cut the uncut pieces off, and lightly sanded the inside of the arch to remove some swarf.

EVALUATION:



9. I used a biscuit cutter to cut holes for biscuits, to improve the stability of the drum.
10. My teacher and I then used strap clamps, as well as standard clamps to glue my Cajón together.

EVALUATION: Unfortunately, for unknown reasons, the biscuit holes were not cut in the same place of the end grain – some were too high and some were too low. For this reason, we were only able to use two biscuits out of a total 18. Although this was annoying and meant that the box would not be as strong, I decided to rectify this issue by gluing the 90 degree offcuts from the mitres.

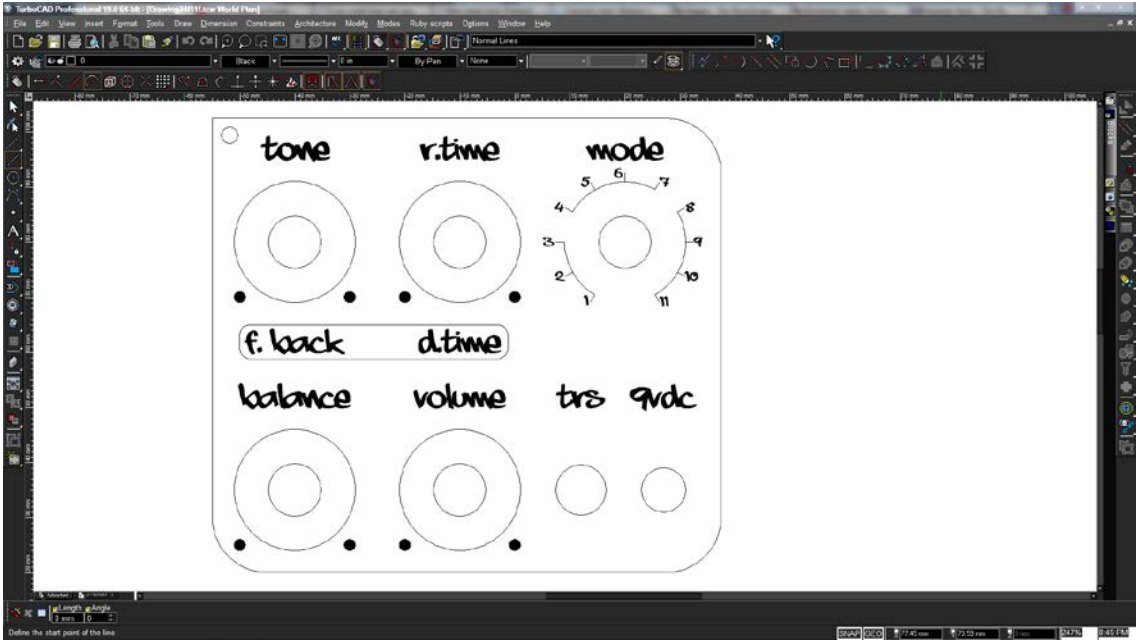
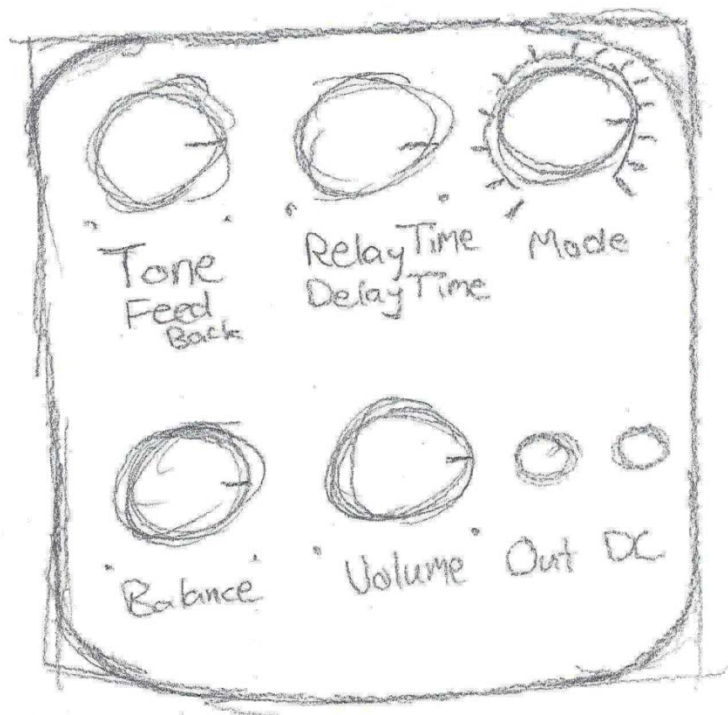


I let the glue set overnight.

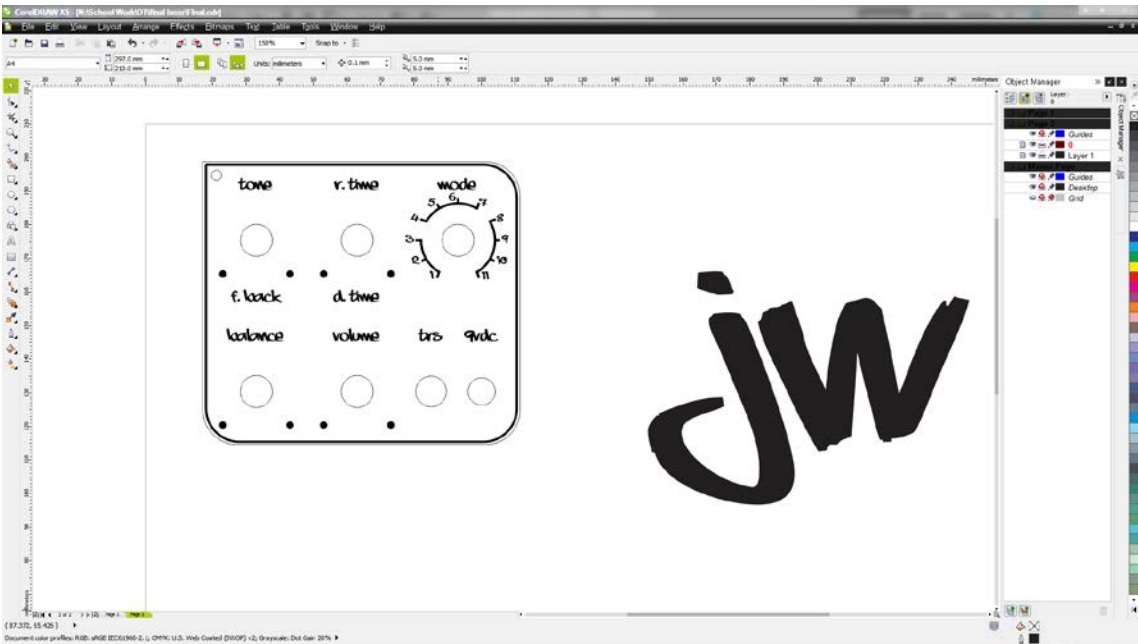
11. I measured the final height and width of the box so that I could mark out the wood for the tapa. I then marked out the wood and my teacher cut it with the track saw.



12. I used several processes to design a plastic back plate which would have the correct positions and labels for the controls of the effects. I began by drawing the back plate how I imagined it, and then translated the design into TurboCad with the correct scale.



Once I was happy with the design, I transferred the design into Corel Draw, which is a vector graphics software that the laser cutter is intended to be used with. This transfer was fairly simple, as Corel was able to import the file that was saved by TurboCad. In Corel, I checked all line widths and holes to ensure that they remained correctly scaled and would look good in the final product.



For the logo on the front, I had tested the various font sizes earlier in the project, and so I was able to use only Corel Draw for the logo.

EVALUATION: There were several other designs that I had made earlier that were discounted because of the number of controls that the effects used. An earlier design included an on/off button on the rear, which I found was unnecessary because of the ability to use the output jack as a switch.

13. To perform the laser cutting, I travelled to my friend's business. He owns an Epilog laser cutter that is capable of engraving and cutting both wood and plastic. Using the pre-cut 2.5mm wood for the tapa, I engraved my chosen logo centred and close to the bottom. I cut two tapas, just in case something went wrong with one of them in the finishing process. I used a piece of two-tone plastic to engrave a back plate for the electronics.



14. I used a trimmer to cut a 1.5mm deep hole in the rear of the Cajón where I wanted to mount the back plate. This was necessary to ensure that the back plate sat flush with the wood.



15. Using a sharp knife made from a power-hacksaw blade, I trimmed the edges of the hole to make them perfectly straight and smooth. I then marked on where the holes for each component need to be drilled.



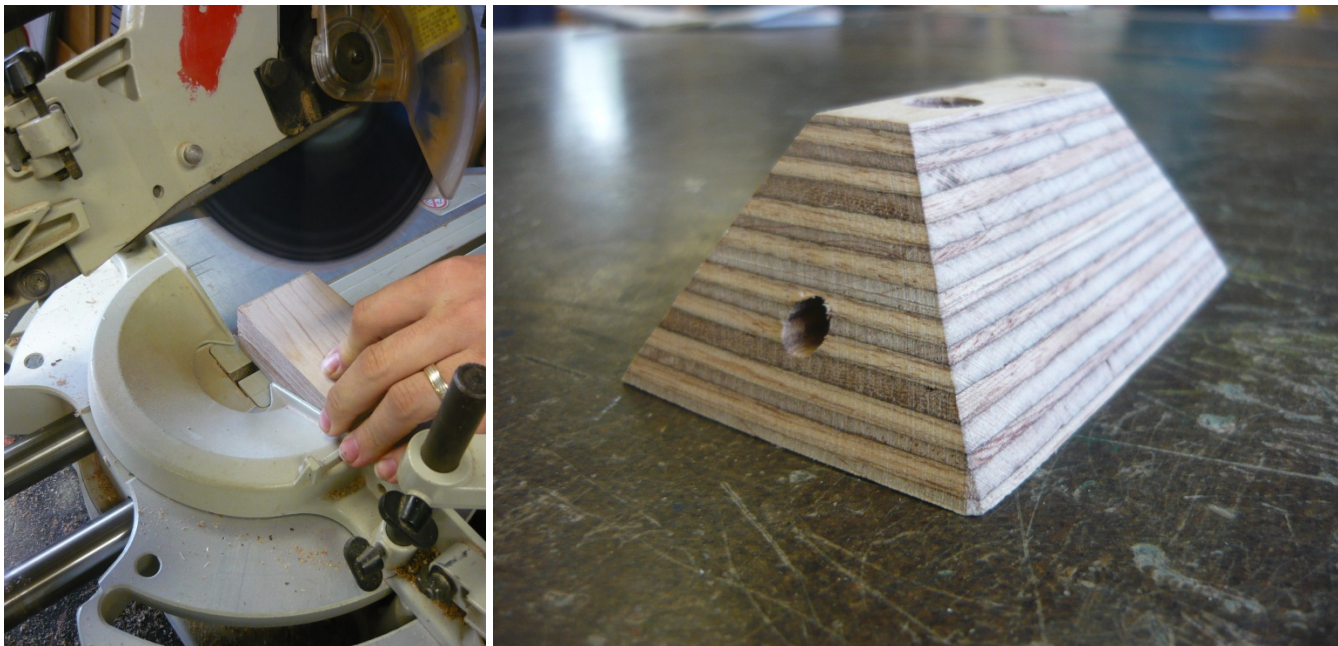
16. I used the triangular offcuts from cutting the mitres to reinforce the inside of the box. Because I was unable to biscuit the joints properly, these offcuts will ensure that the box will not break if a large amount of weight is placed on the top of it. To clamp these offcuts into place while they were gluing, I used pieces of 6mm dowel and wedged them into the box as seen in the picture.



17. Using a drill and various sized drill bits, I drilled holes in the previously routed position so as to allow the electronic components to pass through. Because of the thickness of the wood, it was necessary that I countersunk the components on the inside of the Cajón, which required the use of a Forstner bit. Although I was left with only about 3mm of wood between the inside of the drum and the outside, not including the back plate, I believe this is enough clearance for the back plate to sit and the mounting to remain strong.



18. I decided that because of the effects in the Cajón, it was necessary that I make a foot switch to turn them off and on. I purchased a set of four momentary foot switches for \$13.50, and then began looking at how I should construct the pedal itself. I decided to use two offcut pieces sized 60mm x 110mm of the 19mm plywood from my drum glued together. I glued these together, and my teacher used the drop saw with a 30 degree angle to cut the edges.



This ended with a very high, pyramid shaped pedal which I was not happy with and so I rethought the design. Conveniently, the switch that I purchased fit within one sheet of the plywood; therefore I tested the design to see if I preferred it.

Again, the plywood was cut, and I drilled holes for the switch mechanism and the LED. I also used a Forstner bit to hollow out the inside of the plywood to allow for the wire connections to the switch and LED. I then lacquered the pedal with six coats of polyurethane satin spray-on lacquer.



I drilled a 6.5mm hole for the cable to pass through, before installing all of the electronics.



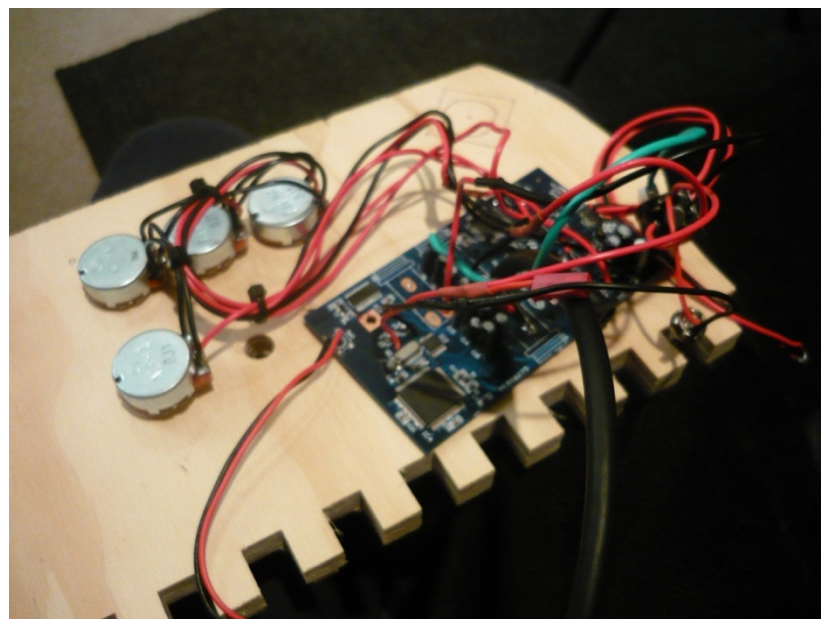
19. I drilled a hole in the rear bottom of my Cajón to mount the socket for the foot switch. This allowed the foot switch to be removable for storage. To do this, I marked out where I wanted the hole. I then drilled using a 3mm bit, followed by a 12mm Forstner bit for a countersink. I then drilled through the centre to allow the chassis of the socket to fit through. I also needed to drill using a large Forstner bit on the inside, as the jack needed a small clearance for it to fit together.



I used a 102mm hole saw to drill the sound hole in my Cajón. I then sanded down the inside of the drum to remove the harsh texture from the cut.



20. I perfected the length of wire between the components for the effects, using a template that I made that is the same size as the final product. This means that I was able to get the length of wire perfectly right. To do this, I used a soldering iron with coloured hookup wire. To perfect the length, I desoldered the wires from the components, shortened their length, and resoldered them.



EVALUATION: I could have saved time and resources had I waited until this step to remove components from the printed circuit board. I wasted wire and solder by lengthening and then shortening the wires. Although this took time, I still believe that it was best way to do it, as it allowed me to test the effects with my prototype.



20. I then sanded down the whole Cajón using 180grit, and then 400grit sandpaper to make it smooth. Using clear polyurethane lacquer, I sprayed the Cajón to give it a clear plastic-feeling coating that protects it from water and dirt. I repeated the process five times, sanding with 400grit between each coat.

SAFETY: It was important to ensure that I lacquered in an area that was not enclosed, as the spray can be harmful when inhaled. Although I was working outside, I still used eye protection with a face mask to ensure that I did not come in contact with any of the lacquer.



I decided to try lacquering the tapa of my Cajón with the same clear satin polyurethane. The lacquer takes 8 hours before it can be recoated, and so I sprayed the job once per day. Although I feared that the lacquer could make the tapa too hard, I wanted to try it anyway to determine if this was true.

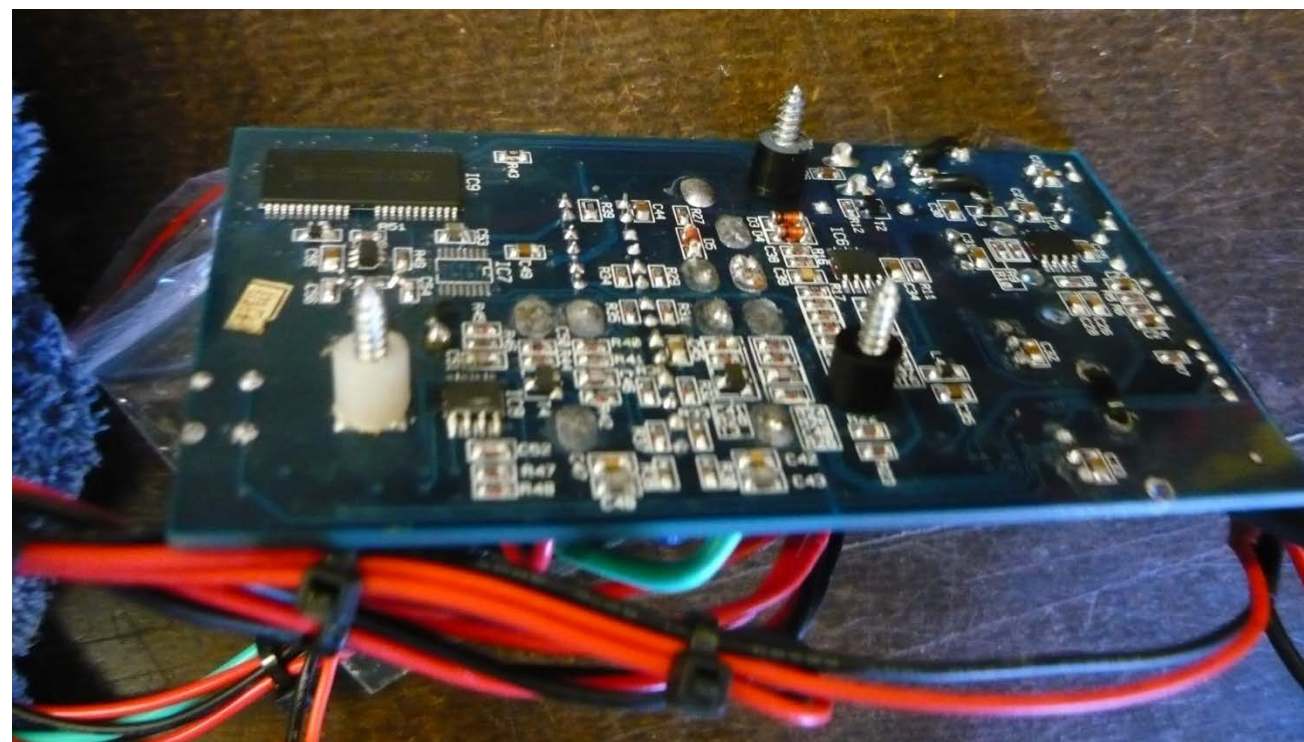
EVALUATION: During the spraying process of the tapa, the weather became bad and there were several days of rain. This meant that I was unable to continue lacquering my project, as I needed to lacquer outside.

When the lacquering was finished, I examined the drum and found several large imperfections in the lacquer.

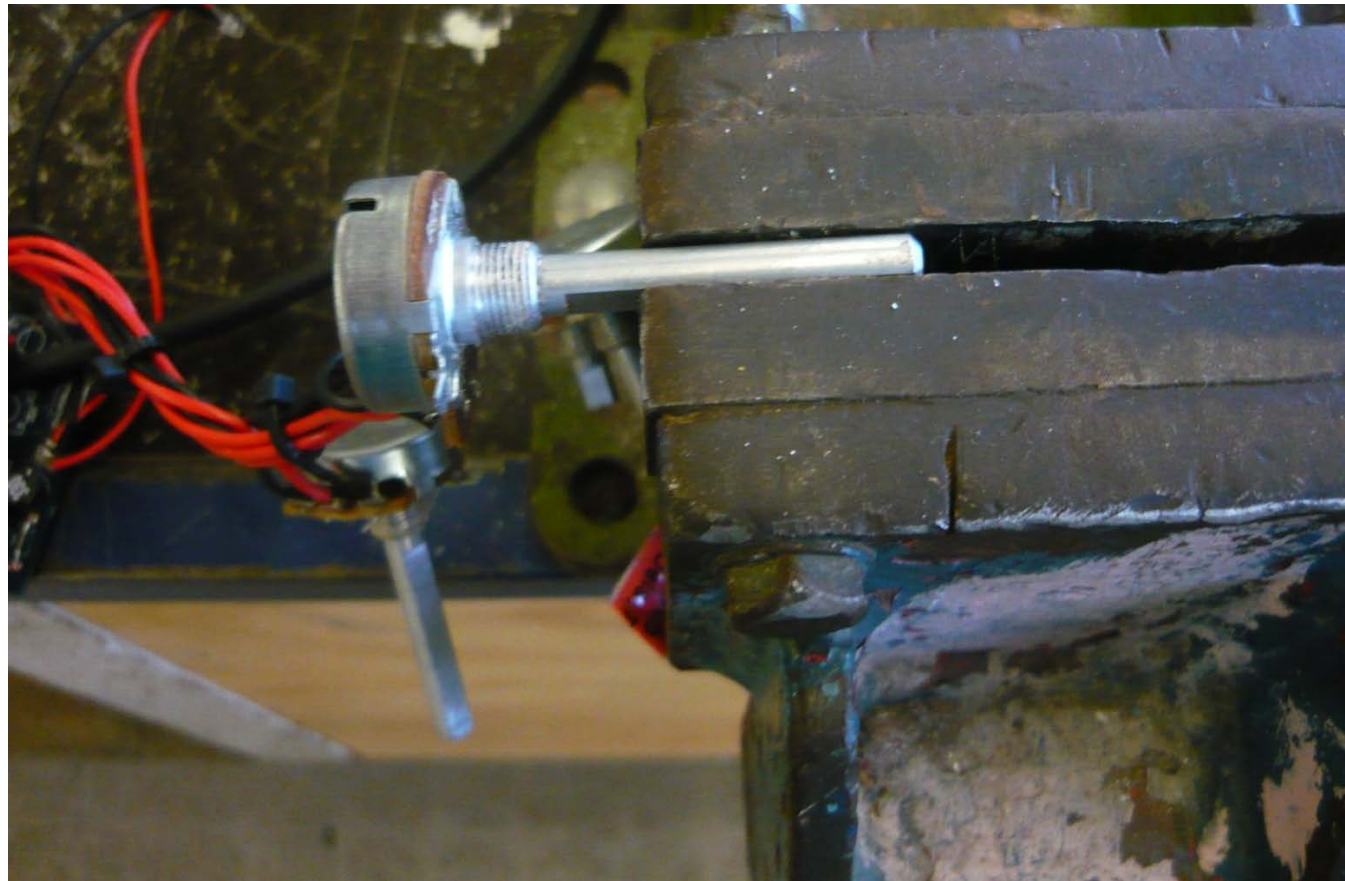


EVALUATION: I was very disappointed with how the lacquering turned out. As can be seen above, there were lots of lighter parts of the wood, I believe due to un-sanded glue residue. Although this seriously affects the aesthetics of the drum, it will not affect the sound quality, and so is not too much of an issue.

21. I was then able to install the electronics into the lacquered Cajón. To mount the circuit board, I used three small nylon standoffs. I drilled through the middle of these to increase the size of the hole, and allow easier installation.



22. After installing the electronics, I realized that I had not yet removed the excess metal from the ends of all the potentiometers. I removed the electronics and used a hacksaw to trim them.



After reattaching the electronics, the knobs would fit much more easily.



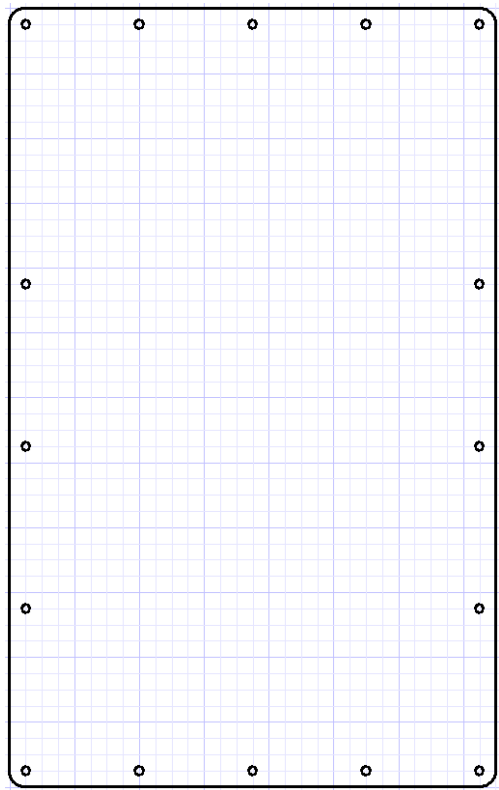
23. I inserted, and attached the plastic back plate which I had laser cut. This plate is attached by the nuts of the potentiometers and jacks.



24. Next, I installed the feet onto the Cajón. I used 12 Gauge 18mm screws to screw the feet into the corners of the Cajón.



25. I drilled and countersunk the holes for the tapa of the Cajón. I chose to use the screw placement common to Meinl Cajónes as I believe that the larger gap in the side screws at the top of the Cajón allows for a greater reverberation of the ‘high’ sound.



I began by marking out all of the holes. I then tested using a 4mm drill bit to drill each hole, but it appeared that the bit available was not quite straight. For this reason I used a 3.5mm bit for every hole first, and then the 4mm bit.



I then used a countersink bit to countersink every hole to fit the screws that I had bought. I ensured that they would be below the surface of the tapa so that the player's hands would not be injured by screws that were poking out.



26. I then used the tapa as a template to predrill the holes in the box. This predrilling was necessary to ensure that the wood wouldn't split as the tapa is screwed in.

EVALUATION: I wasn't totally happy with the predrilling into the chassis of the drum. Although most of these holes were centred, there were several that were a fair bit off. However, none of the holes were so crooked that the screws protruded on the inside or outside of the drum as was seen in the prototype, and although some of the screws were not quite straight, this is not obvious.

27. I used a screwdriver to attach the snares to the snare mechanism and to fix the arc piece to the dowel.



EVALUATION: When I first installed the snares and screwed the tapa on, when the snares were fully engaged, they could hardly be heard. This varied drastically from my prototype because of the strength of the 5ply 2.5mm plywood with lacquer. I moved the screw position of the rotary piece, and so altered the maximum engaged position of the snares. This improved their sound.

28. I used a portable drill with a screw bit to install the tapa onto the drum.

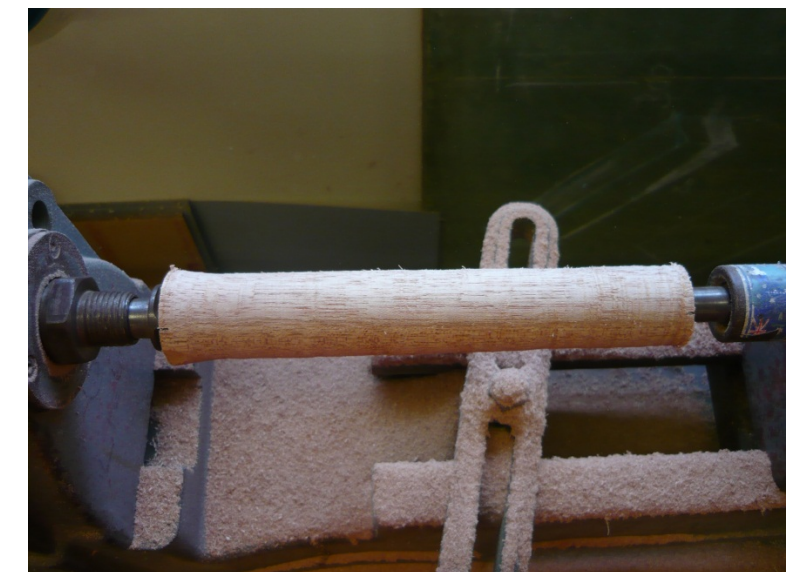
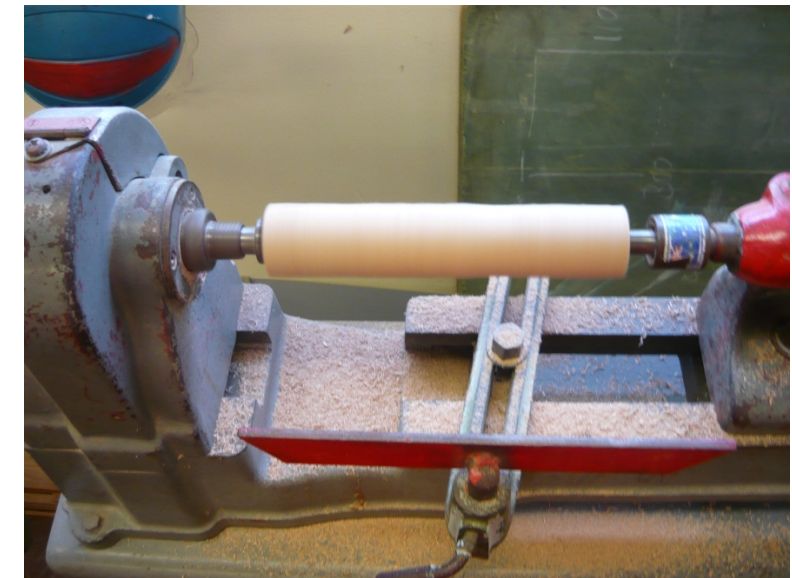


EVALUATION:

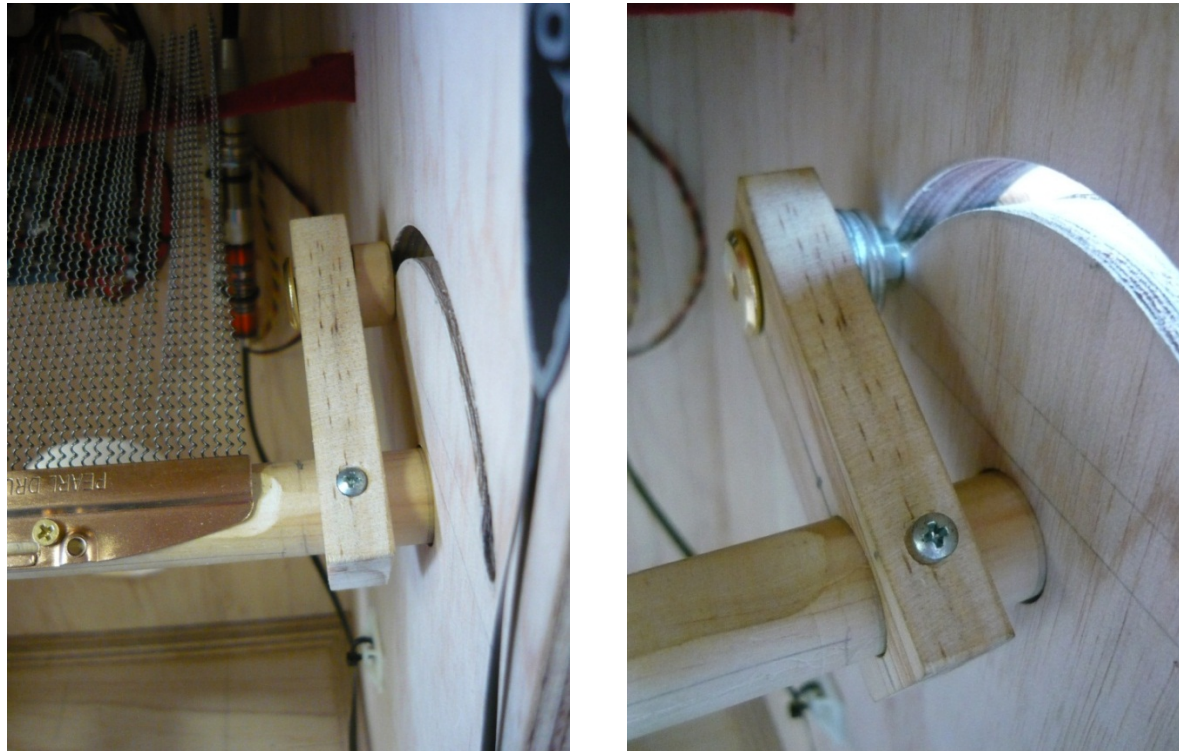
When screwing the tapa on, I found that it did not perfectly fit the rest of the box. Whatever way that I screwed it, at least one edge was not covered. Although this reduced the aesthetics of the design, I was unable to fix it. In future, I would have to ensure that all edges were perfectly square, and this would have been avoided.

I tried playing the Cajón, and was very happy with the sound. I found that using polyurethane lacquer on the tapa has not negatively affected the sound, as it had the deep bass sound as well as the high snare sound that I desired.

29. Using a square piece of wood and a lathe, I turned a knob to use to turn the snares on and off.



30. I was unhappy with the difficulty of turning the snares on and off. To remedy this issue, I removed the snare mechanism, and added a nut and washers to ensure that there was no movement in the mechanism itself other than the intended rotation. After doing this, however, it was still hard to rotate, and so I filed down the thread of the bolt where it was moving through the slot.



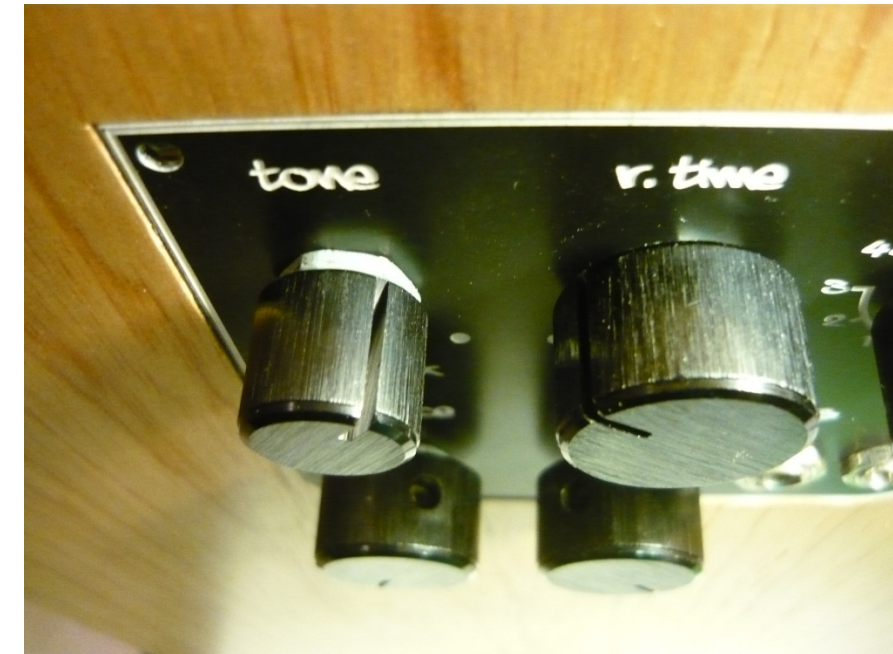
EVALUATION: I was happy with the improved feel of the snares after modifying them. This greatly improved the functionality of the Cajón.

31. I screwed the tapa onto the Cajón again, and sanded the overhanging edges of the drum. By doing this, I ensured that the player's hands would not be injured by unsmooth edges when hitting the top of the front face.



32. I then tested that everything worked as I thought it should. I began by testing the snares, which worked much better than they had before, then testing the effects. I found that the effects were malfunctioning – the feedback time potentiometer was not acting correctly, and the sound of the drum could only be delayed by two beats. I removed the front and spent several hours testing each component until I found the malfunctioning potentiometer. I replaced it and the effects worked again.

33. I screwed black anodized knobs onto each potentiometer to allow the player to more easily change effects. However, I found that some of the knobs that I had purchased did not fit properly.



I had purchased five smaller knobs and one large knob, as I intended to use the large knob for the mode potentiometer. I found that the smaller knobs were actually made for smaller potentiometers, as they did not conceal the bolt the same way that the larger one did. I decided to purchase four more large knobs so that all of the bolts would be covered.





EVALUATION

RECORDING AND APPLICATION OF EVALUATION PROCEDURES THROUGHOUT THE DESIGN PROJECT

These evaluations can be seen throughout the folio, and are identified by the [EVALUATION:](#) label.

ANALYSIS AND EVALUATION OF FUNCTIONAL AND AESTHETIC ASPECTS OF DESIGN

The final product successfully fulfilled all the criteria the evaluate success.

FUNCTION

- Have an easy to use method to adjust the snares while playing the Cajón

The Cajón uses a large knob on the left hand side to engage and disengage the snares. When disengaged, the snares rest on a piece of felt, so that they will not rattle

- Produce a snare-drum-like sound when hit at the top, and a bass-drum sound when hit lower down

The Cajón produces a prominent snare sound when hit close to the top, and a lower bass sound when hit near the lower down.

- Have inbuilt effects that can improve or modify the sound when manipulated

The Cajón has inbuilt delay and reverb effects that modify the digital output sound. The Cajón has 5 knobs on the rear: tone and feedback, relay time and delay time, mode, balance and volume

- Feel nice to play

The Cajón feels nice to play because of the smooth finish on the tapa.

AESTHETICS

- Be aesthetically pleasing – it must look good

The clear satin finish, as well as the colour of the wood itself, makes the Cajon aesthetically pleasing. The logo on the tapa is centred, as is the sound hole on the rear. The effect backplate is not quite level, however I believe that this is hardly noticeable and so only minimally affects the aesthetics of the Cajon.

- Be unique in design

The logo and back plate of the Cajon allow it to be unique in design. No other Cajon ever produced has displayed the **JW** logo on the tapa. I also believe that the colours of the wood I have used are fairly unique, but although I have never seen another Cajon with similar wood colours, one would assume that one has been produced.

FINAL EVALUATION WITH RESPECT TO THE PROJECT'S IMPACT ON THE INDIVIDUAL, SOCIETY AND THE ENVIRONMENT

INDIVIDUAL

The completed project will allow me to improve my Cajón playing. I can also use it to experiment with different percussion sounds, and to play with other people. Not only this, but the project as a whole has provided me with an amazing opportunity to increase my knowledge and skills, particularly in woodworking.

It has been interesting to learn about different types of wood and the different types of sound they produce, as well as taking apart an effects pedal, and allowing me to see a lot of its inner workings.

SOCIETY

The project has had a minimal impact on society. Many people have helped me to make the project through the process of giving advice. Additionally, I will no longer need to purchase a commercially manufactured Cajón if and when I wish to improve my skills or play with other people.

The completed product will positively impact on society through the opportunity it gives others to learn more about unusual percussion instruments, and their background cultures, as well as to simply enjoy the sounds that they make.

ENVIRONMENT

As described in Consideration of Design factors on Page 15, there has been a minimal impact on the environment due to the small amount of resources used for the project.

RELATIONSHIP OF THE FINAL PRODUCT TO THE PROJECT PROPOSAL

I have successfully produced a working Cajón which has an inbuilt pickup and effects. Although I will still be required to carry a pedal with me when I wish to play the Cajón, the pedal is much smaller and lighter than the original effects pedal, and will be easier to use, as it only has one button.

Although the method of modifying the effects is somewhat difficult and could be confusing to some, I still believe that it was my best option, and is the simplest that it could be. However, if the Cajón was to be commercially produced, an in-depth instruction manual would need to be shipped with the product.

The Cajón can also be played without the effects, and even completely acoustically. Whilst being played like this, the Cajón still sounds very good and so can be played anywhere – with or without power.

Overall, I am very happy with the completed product – the information and skills that I have gained throughout the process will benefit me in the years to come, and I have had fun.

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